<https://www.sciencedirect.com/science/article/pii/S0306437919302728>

**Abstract**

IoT (Internet of Things) platforms are key enablers for smart city initiatives, targeting the improvement of citizens’ quality of life and economic growth. As IoT platforms are dynamic, proactive, and heterogeneous socio-technical artefacts, systematic approaches are required for their development. Limited surveys have exclusively explored how IoT platforms are developed and maintained from the perspective of information system development process lifecycle. In this paper, we present a detailed analysis of 63 approaches. This is accomplished by proposing an evaluation framework as a cornerstone to highlight the characteristics, strengths, and weaknesses of these approaches. The survey results not only provide insights of empirical findings, recommendations, and mechanisms for the development of quality aware IoT platforms, but also identify important issues and gaps that need to be addressed.

## 1. Introduction

One of the key enablers (инструмент реализации) of a smart city is the IoT platforms [[1]](https://www.sciencedirect.com/science/article/pii/S0306437919302728" \l "b1). An IoT platform is a set of technology-enabled (поддерживающая) entities (сущность) including physical smart objects (e.g. sensors, actuators, cameras, smart tags, and tracking labels (метка отслеживания)) as well as (так же как) software services and systems that are connected and working together. An IoT platform, typically, collects and processes massive amount (массивное количество) of data generated by smart city entities in a real-time fashion (стиле) to improve city services to citizens [[2]](https://www.sciencedirect.com/science/article/pii/S0306437919302728" \l "b2), [[3]](https://www.sciencedirect.com/science/article/pii/S0306437919302728" \l "b3). IoT platforms are a backbone (основание) for many smart cities such as those are in Europe [[4]](https://www.sciencedirect.com/science/article/pii/S0306437919302728" \l "b4), China [[5]](https://www.sciencedirect.com/science/article/pii/S0306437919302728" \l "b5), and United Arab Emirates [[6]](https://www.sciencedirect.com/science/article/pii/S0306437919302728" \l "b6).

An IoT platform may constitute (составлять) millions of smart objects and software services that should operate in an orchestrated way to provide active sensing (измерение), and smart reasoning (выводы) for citizens. As the development of such socio-technical artefacts is a complex and challenging process, the need for adopting (принятие) systematic engineering approaches (подходы), i.e. engineering methodologies or information system development methods,[1](https://www.sciencedirect.com/science/article/pii/S0306437919302728" \l "fn1) to develop IoT platforms is pivotal (основной) [[7]](https://www.sciencedirect.com/science/article/pii/S0306437919302728" \l "b7). Engineering approaches (подходы) are the core of all well-engineered IT artefacts as they provide a means for applying (применяющейся) practices, design decisions (решение), and techniques for developing information systems [[8]](https://www.sciencedirect.com/science/article/pii/S0306437919302728" \l "b8). Analogically, it is evident (очевидно) that an IoT platform development is, after all, essentially a type of information system development [[9]](https://www.sciencedirect.com/science/article/pii/S0306437919302728" \l "b9), [[10]](https://www.sciencedirect.com/science/article/pii/S0306437919302728" \l "b10). Considering this analogy, adopting (принятие) an engineering lifecycle (жизненный цикл) perspective for managing the complexity of IoT platform development is acclaimed (провозглашенный) as it takes precedence (первенство) over an ad-hoc (узкоспециализированный) use of implementation (реализация) techniques and technologies which are likely to deliver a vulnerable (уязвимый) and poor quality (низкое качество) platform [[9]](https://www.sciencedirect.com/science/article/pii/S0306437919302728" \l "b9). This has been acknowledged (признано) by earlier research suggesting IoT development should be conducted (организовываться) from the engineering lifecycle point of view [[11]](https://www.sciencedirect.com/science/article/pii/S0306437919302728" \l "b11). According to the Gartner’s report [[12]](https://www.sciencedirect.com/science/article/pii/S0306437919302728" \l "b12):

“…developing and standardising the process for building IoT solutions and then guiding the evolution and improvement of that process is key. This will help organisations in creation of IoT solutions easier and more reliable because these initiatives will follow a process that incorporates the organisation’s experience and accrued best practices in IoT solution development”.

Moreover (более того), Fortino et al (и другие). who designed an approach (подход) for a smart tourism IoT platform, state [[13]](https://www.sciencedirect.com/science/article/pii/S0306437919302728" \l "b13):

“…to fully exploit the widely recognised smart objects’ potential in analysing, designing and implementing IoT eco-systems, well-defined development methodologies are required”.

Nevertheless, the development processes for IoT has not yet been explored as the hype (шумиха) suggests. Practitioners (практические специалисты) may be arguably referred (возможно упоминают) to traditional engineering lifecycles (e.g. SDLC (ЦРС) ) and software engineering practices to develop an IoT platform. However, as it will be discussed in Section [4](https://www.sciencedirect.com/science/article/pii/S0306437919302728" \l "sec4), an IoT platform development endeavour (стремление) is distinct (отличается) from the traditional information system development in several ways. Software components, mobile applications, and backbone services, that are combined together to offer IoT services, are developed and maintained in a typical information systems project. On the other hand, hardware components of a platform should be able to communicate with other software components, which can be a complete project on its own and thus needs to be developed and maintained (поддерживаться) via a different lifecycle. Apart (отдельно) from technical challenges, an IoT platform development may involve multiple domains (области) and thus a diversity (разнообразие) of stakeholders (заинтересованные стороны) and their requirements (требования) [[14]](https://www.sciencedirect.com/science/article/pii/S0306437919302728" \l "b14). Bringing (приносящий) these different lifecycles together implies (подразумивает) the need for engineering new engineering approaches (подходы) or augmenting (увеличение) existing ones to incorporate (включить) and address the abovementioned (вышеупомянутый) issues in the course of an IoT platform development.

**Abstract**

This article is about IoT (Inthernet of Thinks) platforms. IoT is a difficult system, development of such system is a complex and challenging process, the need for adopting systematic engineering approaches. Nevertheless, the development processes for IoT has not yet been explored. But they must be differ from classical Information Systems development processes.

**Retelling**

1. One of the key enablers (инструмент реализации) of a smart city is the IoT platforms.
2. An IoT platform is a set of technology-enabled (поддерживающая) entities (сущность) including physical smart objects (e.g. sensors, actuators, cameras, smart tags, and tracking labels (метка отслеживания)) as well as (так же как) software services and systems that are connected and working together.
3. IoT platforms are a base for many smart cities in Europe [[4]](https://www.sciencedirect.com/science/article/pii/S0306437919302728" \l "b4), China [[5]](https://www.sciencedirect.com/science/article/pii/S0306437919302728" \l "b5), and United Arab Emirates.
4. The development of such socio-technical artefacts is a complex and challenging process, the need for adopting (принятие) systematic engineering approaches.
5. Analogically, it is evident (очевидно) that an IoT platform development is a type of information system development.
6. Nevertheless, the development processes for IoT has not yet been explored.
7. However, an IoT platform development differ from the traditional information system development in several ways.
8. Hardware components of a platform should be able to communicate with other software components, which can be a complete project on its own and thus needs to be developed and maintained via a different lifecycle.
9. We need for engineering new engineering approaches (подходы) to incorporate (включить) and address the specific issues in the course of an IoT platform development.

## 1. Introduction

enablers (инструмент реализации)

technology-enabled (поддерживающая)

entities (сущность)

tracking labels (метка отслеживания)

as well as (так же как)

massive amount (массивное количество)

fashion (стиле)

backbone (основание)

constitute (составлять)

sensing (измерение)

reasoning (выводы)

adopting (принятие)

approaches (подходы)

pivotal (основной)

approaches (подходы)

applying (применяющейся)

decisions (решение)

it is evident (очевидно)

adopting (принятие)

lifecycle (жизненный цикл)

acclaimed (провозглашенный)

precedence (первенство)

ad-hoc (узкоспециализированный)

implementation (реализация)

vulnerable (уязвимый)

poor quality (низкое качество)

acknowledged (признано)

conducted (организовываться)

Moreover (более того)

et al (и другие)

approach (подход)

hype (шумиха)

Practitioners (практические специалисты)

may be arguably referred (возможно упоминают)

SDLC (ЦРС)

endeavour (стремление)

is distinct (отличается)

maintained (поддерживаться)

Apart (отдельно)

domains (области)

a diversity (разнообразие)

stakeholders (заинтересованные стороны)

requirements (требования)

Bringing (приносящий)

implies (подразумивает)

approaches (подходы)

augmenting (увеличение)

incorporate (включить)

abovementioned (вышеупомянутый)