Carrying out Institutional Work practices to promote the Internet of Things in beef cattle in the state of Mato Grosso do Sul/Brazil

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Realización de prácticas de Trabajo Institucional para promover el Internet de las Cosas en la ganadería de carne en el estado de Mato Grosso do Sul/Brasil

Realização de práticas de Institutional Work para fomento da Internet das Coisas na pecuária bovina de corte no estado de Mato Grosso do Sul/Brasil

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Abstract: The objective of this study is to analyze how the implementation of Institutional Work practices fosters the adoption of the Internet of Things (IoT) in cattle farming of cutting in the state of Mato Grosso do Sul/Brazil. A qualitative, deductive and exploratory study was adopted, with semi-structured interviews and secondary data collection. Sixteen institutional actors, public and private, from the state of MS, who work or have worked on projects using IoT for the production of beef cattle, were interviewed. Data was analyzed using Bardin's (2009) content analysis and the help of the qualitative analysis software, ATLAS.ti8®. It was observed that only four Institutional Work practices were identified as existing in the macro environment of the state of Mato Grosso do Sul/Brazil, namely Advocacy, Constructing identities, Constructing normative networks and R&D. Another four practices were identified as partially existing, and two practices as non-existent. Among the contributions presented are the aggregation of empirical studies into the field of knowledge of IoT, agribusiness and the theory of Institutional work, a topic rarely addressed until then. As a contribution to the practice, the detail of the Institutional work carried out in the state of MS, allowing federal, state and private public actors to make conscious and efficient efforts to boost and structure IoT in the Brazilian rural productive sector.

Keywords: Internet of things, Beef cattle, Institutional Work, Agriculture, Public policy.

Resumen: El objetivo de este estudio es analizar cómo la implementación de prácticas de Trabajo Institucional incentiva la adopción del Internet de las Cosas (IoT) en la ganadería de carne en el estado de Mato Grosso do Sul/Brasil.

Se adoptó un estudio cualitativo, deductivo y exploratorio con entrevistas semiestructuradas y recolección de datos secundarios. Fueron entrevistados dieciséis actores institucionales, públicos y privados, del estado de MS, que trabajan o han trabajado en proyectos que utilizan IoT para la producción de ganado vacuno. Los datos fueron analizados mediante el análisis de contenido de Bardin (2009) y la ayuda del software de análisis cualitativo ATLAS.ti8®. Se observó que sólo cuatro prácticas de Trabajo Institucional fueron identificadas como existentes en el macroambiente del estado de Mato Grosso do Sul/Brasil, a saber, Incidencia, Construcción de Identidad, Construcción de Redes Normativas e I+D. Otras cuatro prácticas fueron identificadas como parcialmente existentes y dos prácticas como inexistentes. Entre las contribuciones presentadas se encuentran la agregación de estudios empíricos en el campo del conocimiento de IoT, agronegocios y teoría del trabajo institucional, tema poco discutido hasta ahora. Como contribución a la práctica, se destacan los detalles del trabajo institucional realizado en el estado de MS, permitiendo a los actores públicos federales, estatales y privados realizar esfuerzos conscientes y eficientes para promover y estructurar el IoT en el sector productivo rural brasileño.

Palabras clave: Internet de las Cosas, Ganadería de carne, Trabajo Institucional, Agricultura, Políticas de promoción.

Resumo: O objetivo deste estudo é analisar como a realização de práticas de *Institutional Work* fomentam a adoção da Internet das Coisas (IoT) na bovinocultura de corte do estado de Mato Grosso do Sul/Brasil. Adotou-se um estudo qualitativo, dedutivo e exploratório com realização de entrevistas semiestruturadas e levantamento de dados secundários. Foram entrevistados dezesseis atores institucionais, públicos e privados, do estado de MS, que atuam ou tenham atuado em projetos utilizando a IoT para produção de bovinos de corte. Os dados foram analisados por meio da análise de conteúdo de Bardin (2009) e auxílio do software de análise qualitativa, ATLAS.ti8®. Foi observado que apenas quatro práticas de *Institutional Work* foram identificadas como, existentes, no macroambiente do estado de Mato Grosso do Sul/Brasil, sendo elas a Advocacia, Construção de Identidade, Construção de Redes Normativas e P&D. Outras quatro práticas foram identificadas como, existentes de modo parcial, e duas práticas de como não existentes. Entre as contribuições apresentadas estão a agregação de estudos empíricos ao campo do conhecimento da IoT, do agronegócio e da teoria do *Intitutional work*, tema pouco abordado até então. Como contribuição para a prática destaca-se o detalhamento do *Intitutional work* realizado no estado de MS, permitindo que atores públicos federais, estaduais e privados, possam dispender esforços conscientes e eficientes para

impulsionar e estruturar a IoT no setor produtivo rural brasileiro.

Palavras-chave: Internet das coisas, Pecuária bovina de corte, *Institutional Work*, Agropecuária, Políticas de fomento.

Introduction

The world's population has grown rapidly in recent years, projected to increase from the current 7 billion inhabitants to 9 billion by 2050 (Dinesh & Ramesh, 2018). Given this increase, it will be necessary to produce 70% more food, which puts all countries involved in the agri-food chain under pressure (De Clercq et al., 2018). Among the main countries to meet this demand is Brazil, one of the largest agricultural producers in the world (Carraro et al., 2019). The agricultural sector comprises rural activities: agriculture, livestock, fishing and forestry (Barros et al., 2014).

There are different possibilities to improve Brazilian rural productivity, one of which is the use of information and communication technologies (ICT) in production processes (Banco Nacional de Desenvolvimento Econômico e Social & Ministério da Ciência, Tecnologia, Inovações e Comunicações, 2017). The movement to insert technologies in the rural environment constitutes the so-called "agriculture 4.0" (Carraro et al., 2019). Agriculture 4.0 means the combined interaction of agricultural operations, offering information, in digital form, between and for all sectors and agricultural processes (Zambon et al., 2019). Among the most used 4.0 technologies in rural areas are the Internet of Things (IoT), Cyber Security and Cloud Computing (Carraro et al., 2019).

IoT is identified as one of the disruptive technologies, flagship, in agriculture 4.0, making it possible to use it in the monitoring, control, prediction and logistics of different productive activities (Anitha et al., 2018; Talavera et al., 2017). Researchers from Embrapa Gado de Corte, one of the units of the Brazilian Agricultural Research Corporation (EMBRAPA), cite, in a study on the megatrends of the Brazilian beef cattle production chain, that the IoT has the potential to help meet the increased demand for foods and to be one of the main drivers of change in Brazilian agribusiness by 2040 (Malafaia et al., 2021).

The adoption of IoT in agriculture is advantageous, however, its insertion requires changes in the institutional environment, due to the historically traditional characteristic of the sector (Van Dijk et al., 2011; Zarpelon et al., 2019). Institutional actors directly involved in the technology adopter sector, whether as a development agency, research agency or company that develops IoT products, need to carry out, in a conscious, intentional and organized manner, actions that make it widely institutionalized (De Clercq et al., 2018; Kummitha & Crutzen, 2019).

The work that aims to carry out institutional changes, intentionally and consciously, in order to provoke their legitimacy, has the theory of Institutional Work as its main study lens (Lawrence & Suddaby, 2006). Institutional Work is defined by Lawrence et al. as "the practices of individual and collective actors carried out in order to create, maintain or disorganize institutions" (2011, p. 52). The institution, when seen as an element analyzed through the lens of Institutional Work, is defined as "more or less lasting elements of social life that affect the behavior and beliefs of individual or collective actors, providing models of action, cognition and emotion that allow meaning and stability for social life" (Lawrence et al., 2011, p. 53).

According to Lawrence and Suddaby (2006) nine practices of Institutional Work can be carried out aiming at the creation of new institutions: Advocacy, Defining, Vesting, Identity Construction, Changing Normative Associations, Constructing normative networks, Mimicry, Theorizing and Educational. These practices represent three broad categories: political work; cultural work and technical work (Lawrence & Suddaby, 2006; Perkmann & Spicer, 2008).

The state of Mato Groso do Sul (MS) is an interesting research site to observe the implementation of Institutional Work practices aimed at promoting IoT for cattle farming. This is due to its national projection as a major beef producer and the incentive to adopt information technologies in the rural environment. The state of MS was the third Brazilian state that most slaughtered cattle in 2022, about 11% of the national total (Instituto Brasileiro de Geografia e Estatística [IBGE], 2022). In addition, the state has one of the five largest populations of cattle in Brazil, counting, at the end of 2021, with more than 18 million head, approximately 10% of the Brazilian beef cattle herd (IBGE, 2021). In addition, the state develops different strategies to encourage the adoption of technologies by cattle farms, either privately or through public companies such as Embrapa Gado de Corte (Chiari, 2020).

Given the relevance of the state of MS as a producer of beef cattle, the potential benefits that the insertion of IoT brings to this activity and the possibility of studying this movement through the theoretical lens of Institutional Work, this study aims to analyze how the carrying out Institutional Work practices foster the adoption of the Internet of Things (IoT) in beef cattle in the state of Mato Grosso do Sul/Brazil.

A qualitative, deductive and exploratory study was carried out with the application of semi-structured interviews and secondary data collection as a data collection technique. The interviewees were sixteen institutional actors, public and private, from the state of Mato Grosso do Sul who work or have worked in projects using IoT as a tool to improve the production of beef cattle. In addition to the semi-structured interviews, secondary documents on IoT and beef cattle that have been published on the official pages of the interviewed actors were collected. The interviews, together with the documents, make up the empirical data analyzed using Bardin (2009) content analysis technique. For coding, the Institutional Work categories and subcategories were used, theoretically presented. The analysis was performed using the qualitative analysis software, ATLAS.ti8 ®.

The contributions achieved by carrying out this study are linked to the theoretical field, such as, for example, adding empirical studies to the field of knowledge of IoT, agribusiness and Institutional Work, a topic rarely addressed until then and expanding the work of Zarpelon et al. (2019), when addressing one of the future research suggestions presented by the authors. As contributions to practice, the Institutional Work carried out in the macro environment of the state of MS stands out, allowing federal, state and private public actors to make conscious and efficient efforts to boost and structure IoT in the Brazilian rural productive sector.

The structure of the article is composed of the introduction, followed by the chapter on conceptual development and research propositions. The methodological characteristics and data collection and analysis techniques are presented in the methods section. Then the results are presented and discussed theoretically. Finally, the final considerations section presents the main results, limitations and suggestions for future research.

Conceptual development and research propositions

Internet of Things (IoT) is "a paradigm where everyday objects can be equipped with identification, sensing, networking and processing capabilities that will allow them to communicate with each other and with other devices and services over the Internet to achieve some goal" (Whitmore et al., 2015, p. 261). This technology stands out as one of the main trends among information and communication technologies (ICT), as it evolves in number, applications and types of technological devices embedded around us (Da Xu et al., 2014; Miorandi et al., 2012).

The adoption of IoT in the rural environment, especially in livestock, puts the idea of livestock 4.0 into practice, with emphasis on the concept of smart farm (Rose & Chilvers, 2018). IoT in the rural environment underpins smart farms, as the multiple data obtained, processed, managed and disseminated allow properties to manage to make their processes more efficient (Arvanitis & Symeonaki, 2020).

Studies demonstrate several benefits in monitoring, control, prediction and logistics that IoT can bring to beef cattle producing properties (dos Santos et al., 2019; Jiao et al., 2014; Talavera et al., 2017). However, the adoption of this innovation tends to force institutional change movements, resulting from the traditional nature of the sector (Zarpelon et al., 2019). The theoretical lens of the Institutional work, initially proposed by Lawrence and Suddaby (2006) and used by other authors, including Hall et al. (2019), Jespersen and Gallemore (2018) and Zarpelon et al. (2019), proves to be an adequate theory to observe the efforts made by institutional actors in order to institutionalize IoT in beef cattle.

Institutional theory is a dominant approach to the study of organizations, whether from an economic, political or sociological perspective, however, it has suffered and continues to suffer crises as a result of its own theoretical apparatus (DiMaggio, 1988; Lawrence et al., 2011). One of these weaknesses is being able to explain the changes at the field level and how the actors, even being seen in an institutionalized world with assumptions taken for granted, are able to face the pressures of the institutional environment and make changes (Suddaby & Viale 2011). To try to solve some of these concerns, the neoinstitutional theory emerged, which questions the recognition of the relationship between organizations and their environment, highlighting issues such as actors, agency and institutions (Meyer, 2010; Scott, 2013).

The neoinstitutional vision brought to the center of institutional discussion the lived experiences of organizational actors and how they interfere in institutions (Lawrence et al., 2011; Zarpelon et al., 2019). As one of the main lenses within neoinstitutionalism is Institutional work, defined by Lawrence et al. (2011, p. 52) as "the practices of individual and collective actors aiming to create, maintain and disorganize institutions". This strand of neoinstitutional theory brings institutional actors, whether individual or collective, to the forefront by worrying about the everyday and intentional practices carried out by them to modify or maintain the institutional environment that surrounds them (Hwang & Colyvas, 2011). Also, one of the main points of Institutional Work is the expansion of the theoretical and empirical research agenda for the entire life cycle of institutions with the insertion, along with the creation of institutions, of institutional maintenance and deinstitutionalization (Hwang & Colyvas, 2011).

The birth and expansion of the study on Institutional Work comes from the interest in observing the cyclical relationship between two intrinsic elements within neo-institutionalism, agency and practice (Zarpelon et al., 2019; Zietsma & Lawrence, 2010). What is ratified when observing that Institutional Work starts from an interest in the efforts made by institutional actors, individual and/or collective, made to create, maintain or close the institutional structures, institutions, where they live and that impose roles, relationships, resources and routines (Binz et al., 2016; Zarpelon et al., 2019). The Institutional Work lens defines an institution as "(more or less) enduring elements of social life that affect the behavior and beliefs of individual or collective actors, providing models of action, cognition, and emotion that enable meaning and stability for social life" (Lawrence et al., 2011, p. 53).

The literature points out three main objectives of Institutional Work: to create, maintain and disorganize institutions, with the creation of institutions being the action of Institutional work that has gained prominence within the field of institutional research (Lawrence et al., 2013). Among the actions that result in the creation of new institutions, Lawrence and Suddaby (2006) identify nine practices used by institutional actors for this purpose: advocacy; Defining; Vesting; construction of identities; changing normative associations; Constructing normative networks; mimicry, Theorizing; and Educational. These are divided into three categories, according to Lawrence and Suddaby (2006) and Perkmann and Spicer (2008): political work; cultural work; and technical work.

The literature presents some Institutional Work actions that actors can carry out with the aim of creating a new institution. In Table 1, these actions that were empirically investigated in this study are presented.

Table 1

Forms, practices and actions related to the creation of institutions

Categories	Practices	Analysis units
Political Work	Advocacy	Political and regulatory support
		Lobby by resources
		Proposing or attacking existing legislation
	Defining	Formal accreditation process
		Certification of actors in a field
	Vesting	Reallocation of property rights
		Changes in the rules of market relations
		Coercive or regulatory authority sharing
Cultural work	Constructing identities	Creation/Reorientation of professions
	Changing normative associations	Replacement of generalized rules
	Constructing normative networks	Proto-Institutions / Normative Networks
Technical Work	Mimicry	Juxtaposition of old and new models
	Theorizing	Elaboration of cause-and-effect chains
		Naming new concepts and practices
	Educational	Educational in the necessary skills and knowledge

Based on Jespersen and Gallemore (2018), Lawrence and Suddaby (2006), Perkmann and Spicer (2008) and Binz et al. (2016).

Figure 1 presents the theoretical model developed to observe the Institutional work carried out, in different sectors, to promote the adoption of the Internet of Things (IoT) as a management tool in beef cattle farming, in the state of Mato Grosso do Sul. According to this model, the practices of Institutional work, represented by the categories of Institutional work, directly, independently and similarly foster the creation of the institution under study.

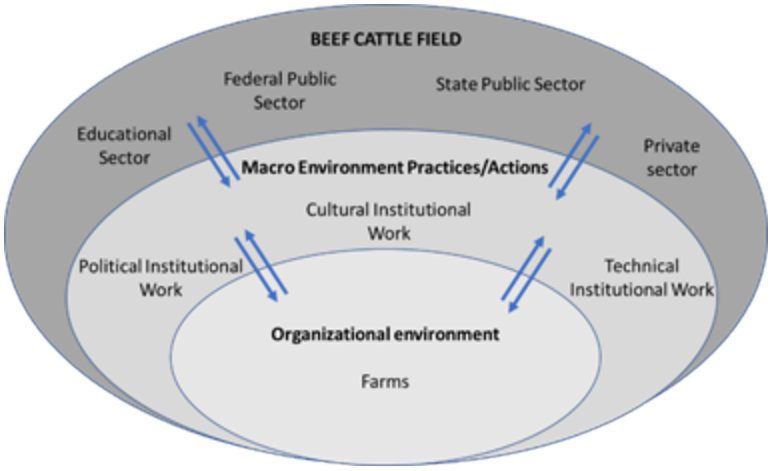

Figure 1
Theoretical research model
Prepared by the author

Policy work, through practices such as advocacy, Defining, and Vesting, is undertaken as a means of tailoring the degree to which the normative characteristics of a new institution are compatible with the interests and agendas of potential adopters (Obeng Adomaa et al., 2022). In Advocacy, actors in a field, government authority or other type of regulatory authority, use social persuasion techniques such as lobbying, changes in legislation, promoting meetings and others, to mobilize political and regulatory support for an innovation (Binz et al., 2016). Actions like these are visualized in Ronaghi and Forouharfar (2020), who state that the implementation of financial support policies by State Agricultural Organizations and the Ministry of Information and Communication Technologies of Iran are essential to facilitate the adoption of IoT by rural producers in the country.

The practice of Defining performs actions that aim to create and clarify roles, define standards and responsibilities in the institutional field (Jespersen & Gallemore, 2018; Lawrence & Suddaby, 2006). As it is an innovative environment still under development, projects, policies and all activities aimed at promoting IoT as a tool for beef cattle farming do not have a clear Defining of responsibilities and rules (Zietsma & Lawrence, 2010). Jayashankar et al. (2018) mention farmers' concerns about ownership and privacy of their farm-level data; they question whether farmers only have the right to access their IoT-originated data or hold ownership over them.

In the practice of Vesting, actions that seek to reallocate property rights, changes in rules in market relations and sharing of coercive authority in a given field are identified (Lawrence & Suddaby, 2006). According to Jespersen and Gallemore (2018, p. 7), the literature that deals with the practice of Vesting "is concerned with clarifying the types of rights conferred on owners of relevant resources and whether or not owners have agency over the property they inhabit, an inherently political issue. Therefore, the adoption of a new technology can be institutionalized as a result of carrying out work practices that openly reflect political work; Therefore, the following proposition is presented:

Proposition 1: Carrying out practices linked to the Institutional Work Politicians encourage the adoption of IoT as a management tool in beef cattle farming in the state of Mato Grosso do Sul.

Cultural work is carried out by carrying out practices such as identity construction, changing normative associations and building normative networks (Lawrence & Suddaby, 2006). The practice of Identity Construction is seen by the literature as a form of work associated with the development of professions, either through the emergence of new professions or the reorientation of existing ones (Lawrence & Suddaby, 2006). Zhang et al. (2016) highlight the Constructing identities as something important from the perspective of reorienting the knowledge and skills of professionals who are in the rural environment, so that the adoption and dissemination of information systems, based on IoT, are comprehensive.

In the practice of Changing Normative Associations, institutional actors reformulate existing normative associations, with the aim of creating a moral and cultural basis for new institutions (Bartram et al., 2020). This movement is seen in da Rosa Righi et al. (2020) in which the work aimed at institutionalizing the MooCare device on livestock farms required abandoning old dairy production practices to benefit from the new information provided by the automation of production processes.

Actions related to the Constructing normative networks are essential when there is a need to overcome complex challenges that prevent the creation of new institutions (Jespersen & Gallemore, 2018). Building an environment for cooperation and participation around payment for ecosystem services was one of the ways Indonesian actors used to institutionalize this practice (Jespersen & Gallemore, 2018). Through cultural work practices, institutional actors seek to establish relationships between the characteristics of a new institution and cultural values, beliefs and decision-making practices that exist and are widely accepted by potential adopters (Obeng Adomaa et al., 2022; Perkmann & Spicer, 2008). In view of this, the following proposition is presented:

Proposition 2: Carrying out practices linked to the Institutional Work Cultural promote the adoption of IoT as a management tool in beef cattle, in the state of Mato Grosso do Sul.

No Institutional technical work, the institutional actors seek to create a new institution, through three practices: mimicry, theorization and Educational (Binz et al., 2016). These practices are related to the cognitive-cultural pillar of institutions and, when carried out, build "mental models" and worldviews that alter abstract categorizations and their meanings within the field (Lawrence & Suddaby, 2006; Perkmann & Spicer, 2008).

When performing the practice of Mimicry, institutional actors seek to associate new technologies with something that already exists and is institutionalized, thus facilitating their acceptance and institutionalization in the organizational environment (Jespersen & Gallemore, 2018). Rutherford and Schultz (2019) mention that, when new institutions emerge in a dense institutional context, one of the options to be adopted by actors is to nest them within the context of existing formal institutions. Theorizing practice aims to develop and specify abstract categories and elaborate cause and effect chains for the new institutions created (Binz et al., 2016). Hall et al. (2019), mention that demonstrating the technological viability of innovative products is necessary, therefore, companies that develop these technologies need to engage to articulate the benefits of technology for potential adopters.

Educational practice takes place with the aim of developing skills and knowledge needed to support the new institution (Perkmann & Spicer, 2008). This institutional practice is part of an important cognitive task, considering the actors' need to adapt to the new connections and control mechanisms that arise with the new institution (Lawrence & Suddaby, 2006). The Educational of actors in the skills and knowledge necessary for the adoption of IoT products are critical to the success of the acceptance and dissemination of agricultural information systems, since many rural workers do not have the minimum knowledge to access, use, respond and act with the information generated by these devices (Zhang et al., 2016). Given the above, it is believed that promoting the adoption of IoT on cattle farms can result from carrying out practices related to technical work. In this way, the following proposition is presented.

Proposition 3: Carrying out practices related to Institutional Work Technical promote the adoption of IoT as a management tool in beef cattle farming in the state of Mato Grosso do Sul.

Method

In view of the objective of analyzing how Institutional Work practices foster the adoption of the Internet of Things (IoT) in beef cattle in the state of Mato Grosso do Sul/Brazil, an exploratory qualitative research was adopted. Two qualitative research techniques were used as data collection instruments: interviews and documentary research. The observational study style is a cross-sectional study, which analyzes data from a representative subset of the population, considering a specific moment in time (Karahanna et al., 1999).

The field of study is the Brazilian state of Mato Grosso do Sul and is due to its representativeness in cattle production and adoption of information technologies in livestock. The sample interviewed was composed of institutional actors who carry out or have carried out project(s) that contemplate IoT technology and beef cattle, in the state of MS or that directly impact the state. The selection of respondents occurred, first, by searching the internet, on the Google®, by institutional actors who appeared in academic works, reports and various publications, using the terms "IoT", "Internet of Things" and "Mato Grosso do Sul" simultaneously. In a second moment, new interviewees were selected, using the non-probabilistic sampling strategy, called snowball (Vinuto, 2014).

Secondary data corresponds to documents that include laws, regulations, articles, dissertations, theses or reports that appeared on the websites of respondents until December 2022; all related to IoT and cattle farming. The date of 2017 was stipulated as the minimum period for publishing these data, considering that it is the period that contemplates the launch of the study "Internet of Things: an action plan for Brazil", developed by BNDES and MCTIC, in 2017.

The interviews were carried out, following a semi-structured script developed based on the theoretical variables, Table 1, pointed out in the literature as ways of carrying out the Institutional practices work. The validation of the interview script was carried out by three academic researchers, being carried out in two rounds. Data triangulation was performed by comparing data acquired from multiple sources of evidence (Creswell, 2010; Yin, 2015). Theoretical saturation was identified when faced with the lack of interviewees in the research field.

Table 2 presents the list of institutional actors interviewed and whose published documents on IoT were collected as a source of secondary data. Nineteen interviews were carried out, corresponding to 16 institutional actors who made up the final population of this research. Here it is referred to as the total population studied, as no other relevant new interviewees were identified by the aforementioned techniques. In total, there are more than 17 hours of recorded interviews, which resulted in 261 pages of transcribed content. Secondary data correspond to 35 documents, 151 pages, which include laws, regulations, articles, dissertations, theses or reports that appeared on the websites of the 16 actors interviewed until 08/11/2022; all related to IoT and cattle farming.

Table 2
Institutional actors that make up the target audience for interviews

Code	Sex	Sector	Occupation area	Interview time	Transcription Pages	Date
ES01	M	Educational Sector	Computer science teacher	01:01:51	14	04/05/2022

ES02	M	Educational Sector	business incubator	00:53:24	8	03/11/2022
ES03-1	M	Educational Sector	Professor/ Researcher	00:43:50	12	03/15/2022
ES03-2	M	Educational Sector	Professor/ Researcher	01:02:07	16	03/28/2022
ES04-1	M	Educational Sector	Professor/ Researcher	00:59:30	15	09/30/2021
ES04-2	F	Educational Sector	Lecturer/Researcher in the Graduate Program in Applied Computing	00:53:59	15	10/08/2021
PS01	M	Private sector	precision livestock	00:41:46	13	12/14/2021
PS02	M	Private sector	owner partner	00:54:48	12	05/12/2022
PS03	F	Private sector	Customer success	01:19:55	23	06/14/2022
PS04	F	Private sector	Owner partner	01:05:01	15	03/08/2022
PS05	M	Private sector	owner partner	00:57:25	15	12/07/2021
PS06	F	Private sector	Innovation area analyst	00:37:40	11	10/22/2021
PS07	M	Private sector	Center of Excellence in Beef Cattle	00:40:06	9	10/08/2021
SPS01	M	State Public Sector	CEO	00:46:19	13	10/20/2021
SPS02-1	M	State Public Sector	Superintendence of science and technology, production and family farming	00:46:17	12	10/14/2021
SPS02-2	F	State Public Sector	Coordination of science, technology and innovation	00:32:47	8	10/22/2021
FPS01	M	Federal Public Sector	Information Technology Supervisor	01:28:00	25	09/29/2021
FPS02	M	Federal Public Sector	Agricultural Innovation Support Department	00:54:22	14	07/15/2022

FPS03	F	Federal Public Sector	General Coordination of Digital Transformation	00:45:59	11	08/05/2022
Total				**17:05:06**	**261**	

Prepared by the author

As the data collection took place during the covid-19 pandemic, the interviews were carried out 100% remotely, with the support of the Google Meet ® application. The research was submitted and approved by the Research Ethics Committee (CEP), of the Federal University of Mato Grosso do Sul – UFMS, and meets the requirements of the National Research Ethics Commission – CONEP. Note that some organizations have more than one respondent; this is due to the need to interview more than one person responsible for collecting the information sought in the research, either by indication of the first interviewee, or by choice of the researcher for additional clarification.

As a procedure for data analysis, content analysis according to Bardin (2009) was adopted. The chosen analysis logic was the deductive method described by Kripka et al. (2015, p. 63), as: "In the deductive method, the categories are constructed before proceeding with the analysis of the research "corpus", that is, the text produced. They are called "a priori" categories, being deduced existing explicit theories". The broad categories of Institutional Work were used as categories and Institutional Work practices were used as subcategories. The interviews conducted on video were transcribed with the support of the Transkriptor® website. All data collected were analyzed with the help of the qualitative analysis software, ATLAS.ti8®.

Presentation and discussion of results

The logic used for data analysis was deductive logic, however, the researchers left open the possibility of new categories emerging during this process, which actually occurred. During the analysis, a new category of analysis was observed, "Research and Development", allocated by the researchers, given their empirical characteristics, as part of the Technical Institutional Work.

We sought to classify the ten Institutional Work practices into "exist", "partially exist" or "does not exist" for each sector interviewed and in the macro environment of the state of MS as a whole. For this, the following criteria and analysis steps were used: (1) for visualization in each sector, a classification was established according to the percentage of positive responses from the interviewed actors, in each sector investigated: if a total equal to or greater than 70% of respondents highlighted a practice as existing in the macroenvironment, it was listed as existing (E); if the number of positive statements was between 30% and 69%, it was classified as partially existing (EP); below 30%, such a practice was listed as non-existent (NE). (2) Based on the first result found, all sectors were added into just one, the macroenvironment of the state of MS. In case most sectors are listed similarly, the final ranking followed the prevailing ranking. In cases where two sectors are classified as non-existing or existing, and two sectors as partially existing, it was decided to evaluate the macroenvironment according to the "extreme" classification. In cases where two sectors are listed as existing and two as not existing, classify as partially existing.

Table 3 brings the analysis carried out according to the perception of each institutional actor interviewed, with the results being presented by sector and later in the entire state of MS. As noted, only four Institutional Work practices were identified as existing in the MS macro environment, namely Advocacy, Constructing identities, Constructing normative networks and R&D. Another four practices were identified as partially existing, and two Institutional Work practices, Vesting and Educational, as non-existent in the macro environment of the state of MS.

Table 3

Classification of Institutional practices work according to the perception of existence according to the actors interviewed

Institutional work	Educational Sector	Private sector	State Public Sector	Federal Public Sector	Macro environment
Advocacy	Exists	Partially existing	Exists	Exists	Exists
Defining	Exists	Does not exist	Does not exists	Exists	Partially existing
Vesting	Does not exist	Does not exist	Does not exist	Partially existing	Does not exist
Constructing identities	Exists	Exists	Partially existing	Partially existing	Exists
Changing normative associations	Partially existing	Partially existing	Does not exist	Partially existing	Partially existing
Constructing normative networks	Exists	Exists	Exists	Exists	Exists
Mimicry	Exists	Partially existing	Does not exist	Partially existing	Partially existing
Theorizing	Partially existing	Partially existing	Partially existing	Partially existing	Partially existing
Educational	Partially existing	Does not exist	Partially existing	Does not exist	Does not exist
R&D	Exists	Exists	Exists	Exists	Exists

Prepared by the author

The results presented support the confirmation of Proposition 1. This confirmation is possible in view of the empirical visualization of the existence of practices related to political work that encourage the adoption of IoT as a management tool in beef cattle, in the macroenvironment of the state of MS. However, among practices linked to political work, only Advocacy and Defining were cited as existing by the actors interviewed. Advocacy is the practice of Institutional work that has the largest number of actions being carried out by state actors. The practice of Defining was mentioned only by two sectors as existing, being classified as a whole as "partially exists". Accomplishing the Vesting practice was not perceived as existing by most of the interviewees.

Among the linked units of analysis, advocacy, only political and regulatory support is receiving broad action, on the part of institutional actors in the state of MS, as can be seen in the following fragment: "We encourage innovators a lot through two FINEP programs that we raise funds, and [SPS01] applies, which is Centelha and Tecnova. They are economic grants without return" (SPS02). This result is in line with the study by Wahid and Sein (2014), in which political support proved to be an interesting tool to endorse research and projects that use IoT for beef cattle.

According to the interviews, the main political actions, at the local level, are developed in partnership between the actors SPS01 and SPS02, state public sector, in which organizations use two ways to support the development of projects aimed at IoT in cattle farming: the first, through public notices to support research, granting scholarships, from high school to graduate school. The second, through innovation promotion programs, Centelha MS and Tecnova, which provide local companies, selected by public notice, economic subsidies, without refund:

> The Government ran two notices and will run the third, now on a state basis. So they "ran" Centelha, then Tecnova which went, if I'm not mistaken, to ten companies. We were selected as one of them. We borrowed two hundred thousand in non-refundable funds to develop our mobile scale solution under development. (PS05)

Some political support actions were cited as being carried out by the Federal government. The first and best known at national level was the study entitled "Internet of Things: an action plan for Brazil" from which the National Plan for the Internet of Things and the Agro Chamber 4.0 resulted. The carrying out of actions by the Federal government emerges as a national strategy to defend innovation, showing that it has interest and regulatory support from these actors (Jespersen & Gallemore, 2018).

It is noticeable, in the speeches of some educational and private actors, that there is still a lack of political support, since they say that there are rare government actions specifically aimed at IoT or that, at least, contemplate this technology. The lack of action on the part of the state is confirmed by the institutional actor SPS02, a state government agency, in which he mentions that the initiatives carried out are small. Given this fact, the need for more effective public policies for IoT is a reality highlighted by the interviewed actors that is not limited to the reality of the state of MS.

Carrying out programs that financially support research, companies and farms that want to work with IoT is an important practice for local technological development (Das, 2022). This yearning is not limited to the respondents of this research. Chuang et al. (2020) bring, as a result of their study with rural producers in Taiwan, the need for local Taiwanese agricultural administration agencies to develop agricultural policies aimed at the IoT. A result similar to that shown by Ronaghi and Forouharfar (2020), in which the authors suggest that the State Agricultural Organization in Iran facilitate the conditions for the country's farmers to purchase and install IoT technologies.

In the Defining practice, only the formal accreditation action was seen as partially existing in the MS state macroenvironment. The cited accreditation was limited to the process that educational actors and research centers need to go through to develop IoT projects tested on animals. According to respondents ES03 and ES04, in order to develop IoT products for beef cattle, it is necessary that the field tests be released by the Animal Ethics Committee (CUA) of the university to which the project is linked. The practice of Defining involving the handling of cattle was also highlighted in Obeng Adomaa et al. (2022), in which the authors cite the incorporation of certification services as new alternative ways to implement Good Agricultural Practices.

We sought to identify three actions highlighted by the literature as possible, within the practice of Vesting: reallocation of property rights; change of rules in market relations; and sharing coercive or regulatory authority. Depending on the data analyzed, the interviewees say they are unaware of and do not carry out any type of action that is configured within the Vesting practice. However, changes in market relations rules are cited by ES02 as something that should happen.

> One issue is sometimes access to the market. right? That's one of the questions. Another point is to create mechanisms that make these large producers adopt these systems to generate more information about traceability and add value to the product. (ES02)

The analysis of the empirical data confirms Proposition 2, since the practices of identity construction, changing normative associations and Constructing normative networks are carried out in some proportion in the macroenvironment of the state of MS. As an example of actions related to the Constructing normative networks, the formation of cooperation networks was observed, created by actors in the state of MS, which aim to overcome the lack of political support and develop products, research and actions that encourage the adoption of IoT by the rural sector. Cooperation for product development and research is not exclusive to the state of MS. Cedeño et al. (2018) point out that all companies that want to increase their profitability and obtain higher economic results need to cooperate, increasingly among themselves, to develop innovative and intelligent business models using IoT.

The five actors with the largest collaboration networks are, respectively: FPS01, ES04, ES02, PS06 and SPS02. However, all interviewees mentioned participating in a cooperation network aimed at developing projects for the studied technology. As the challenges to the adoption of IoT by livestock are many, one of the most effective ways to overcome them is for governments, central, regional and local agencies to work together, as a driving force, with the objective of developing initiatives for the adoption of this technology (Zhang et al., 2016).

The cooperation network built by FPS01 was the largest and most diverse in terms of the intended objective. In total, the interviewee mentions partnerships with nine other interviewees, some of which were created for certain projects; and others, perennial. Among the temporary partnerships, there is, as an example, the one carried out with the ES04 and PS01, which aimed at developing, in 2016, a passing scale, with IoT technology. For the FPS01, this partnership generated "our most successful piece of equipment in IoT, which is the passing scale". The organization of actors in collaborative networks is beneficial for all involved, even enabling the co-construction of strategies to foster IoT (Michel, 2020).

The most fruitful partnership focused on IoT, within the MS network, was established as follows:

> [PS01] already has know-how in terms of animal weighing, it also has the issue of software for weighing scales. [FPS01] has the scientific and beef cattle know-how. [ES04] also has the same technical, scientific and development expertise. And then the people married the ideas and created the product. (PS01)

The existence of an institutional actor, developing research based on IoT, which has national and international recognition in the livestock sector, as in the case of FPS01, contributes to the strengthening of projects involving this technology nationally. This fact corroborates Chuang et al. (2020) when mentioning that both Taiwan's agricultural administration agencies and local IoT operators should promote the application and transformation of agriculture in the country, through this technology.

The practice of identity construction being carried out in the state of MS is through the reorientation of identities. Some interviewees mention the occurrence of changes in the profile of professionals, either in those who work in the development of IoT products, or in those who work on beef cattle farms. ES03-2, for example, believes that there is a need to create a new profession, capable of generating these technologies and making correct use of them; profession he calls "agroinformatician". According to him, "We need to create a guy who understands computing, understands data processing and understands agriculture to make this connection. These professionals are rare nowadays and when they exist, they are very expensive; they are highly valued". When there are professionals who are specialized and prepared to work with IoT, the legitimization of this technology becomes easier, as these professionals will act as legitimizers (Muzio et al., 2010).

For the majority of respondents, it is not necessary to create new professional training to work with IoT in beef cattle, as portrayed in the statement from ES03-1: "I think there is no need for more professions. I just think there is a need for greater contact, a greater network between the professions that already exist". Therefore, a reorientation in the profile of these professionals is expected, in the sense of being able to work in a multidisciplinary way, since the development and adoption of these products require knowledge in ICT and agriculture (Talavera et al., 2017).

The need to reorient professionals to work with IoT is already seen by respondents as a reality required by the market. This finding reinforces that human factors have been and will always be critical to the successful adoption and dissemination of new livestock technologies 4.0 (Bosch-Sijtsema & Gluch, 2021). Therefore, raising awareness, Educational and training of these professionals will be essential for them to continue to play the important role of disseminating and improving IoT-based management models (Zhang et al., 2016).

Finally, the third practice related to cultural work, Changing Normative Associations, was viewed as partially existing. The most cited regulatory change is related to animal welfare standards. By adopting, for example, an earring with a microchip and a passing scale, IoT products available on the market, in addition to being able to collect and visualize all the information of the life cycle of the animals, in a more efficient way, many inadequate practices of care are abandoned. institutionalized management, such as iron branding and movement of animals for periodic weighing (Wahid & Sein, 2014). Of the total number of actors interviewed, it was possible to identify that seven of them cite actions that change, to some degree, the existing connections between standards and the field thanks to the adoption of IoT:

> Today one of the main points of the use of technology is animal welfare. So, we come in to change how it is still done in several places, which is the movement of the animal in the hose. Thus, when using our technology, you will take the animal to the hose only for vaccination, which then has nothing to do or for boarding the animals. (PS05)

The European Union, for example, signed, in December 2022, a law that prevents the importation of meat from animals raised in deforested areas (Reuters, 2022). Through IoT-based innovations, producers can meet these market demands by creating an IoT-based traceability system to provide product information from farm to fork, satisfying new consumer needs (Talavera et al., 2017).

Proposition 3 was confirmed by the results of the content analysis. However, it should be noted that not all Institutional practices work related to technical work are being carried out in the state of MS. The practice of Educational, for example, was mentioned as non-existent by the interviewees, while the practices of mimicry and Theorizing exist in a partial way. The only practice that exists widely, according to most respondents, is research & development.

The practice of R&D proved to be relevant given the context in which the IoT is being inserted, that is, technological transformation in cattle raising (Zarpelon, 2020). The actors who carry out R&D actions in the state of MS are divided into two groups: those who carry out research and develop IoT products, and those who manage development projects to support these researchs. The main IoT products, resulting from R&D developed in the state of MS, are the passing scales, marketed by PS01 and PS05. Other products such as automatic feeders and devices for monitoring biological characteristics should soon hit the market. This is an important activity in a scenario of innovation, since, as technologies continue to be developed, it is necessary for the emergence of increasingly improved and efficient products that help to overcome problems of previous systems, including cost, range of coverage and usability in outdoor environments (Gsangaya et al., 2020).

The practice of mimicry was classified as partially existing within the macroenvironment of the state of MS. Among the objectives of mimicry is the association of new practices, technologies and rules to something that already exists and is institutionalized, in order to facilitate its acceptance in the institutional and organizational environment (Lawrence & Suddaby, 2006). When it comes to IoT, even though mimicry is not the only way to develop this paradigm, this is a practice sine qua non, as mentioned by the interviewees, since almost all the technologies used in an IoT universe are reused from other innovations. This practice is interesting because, in resistant scenarios with high costs, uniting the "new" and the "old" releases the potential of these new technologies (Sahay et al., 2018).

> Even because what is the Internet of Things? If we think about, for example, precision livestock equipment, they've been around for twenty, thirty years, but they're loose. When we talk about the Internet of Things, we are usually thinking about integration, but they are the same equipment, you know? (FPS01)

Beef cattle raising, as well as other rural environments, has a resistant context, when observing the openness to technological adoption, so inserting changes in cattle production and management practices becomes feasible more quickly, when they can be nested within already formalized institutions (Rutherford & Schultz, 2019). Actors in the educational sector in the state of MS, for example, cite the frequent use of existing technologies to create new products:

> So, you say, ah, did you have to create a totally new thing to do in livestock? No, what I did was take technologies that are already there and change something. Basically that, right? No need to create a new microcontroller. That's what I'm trying to say. You don't need to create a different capacitor in the field of electronics. The components are already there and you just need to organize them to create this solution. (ES01)

Theorizing practice, naming new concepts and practices; and elaboration of cause-and-effect chains, were partially classified as existing by all interviewed sectors. ES03-1 believes that "in my role as a researcher and as I said, in an attempt to remedy a pain in the cattle rancher, I always try to make clear what really brings benefits and what really brings harm, I will not say which can increase the cost of production.

Some private companies highlight this care of taking information about the adoption of IoT to the largest possible number of producers and, therefore, try to participate in events, lectures, fairs, field days and other events that make it possible to take and demonstrate their technology:

> Mato Grosso do Sul is a highly productive state. So, the producers, they really want to know the number. This work we have done, both with visits, participation, lectures, as well as with social networks and participation in the marketing area to try to develop this together with the producer. (PS03)

The public bodies interviewed say that the dissemination of IoT to rural producers is something that they are doing within their possibilities or that it represents one of the next actions to be performed, however, they mention that this is not an easy task, due to the conservative profile of cattle ranchers. The speech of these interviewees is in line with Ronaghi and Forouharfar (2020) in which they mention that agricultural policy makers in a state should promote IoT for intelligent agriculture, highlighting the benefits and presenting the costs that this technology will generate in adoption.

Regarding the naming of new concepts, it was empirically identified that the actors who most carry out this action are the private companies that develop and market their IoT-based cattle products. As an example, there is the passage scale that receives the name of Balpass; the electronic trough, the e- feeder; and the Bovine Electronic Platform (BEP).

The only practice of Institutional work, linked to technical work, which was not empirically observed as existing in the macroenvironment of the state of MS was Educational. This is contrary to what is mentioned in different studies on instructional work and IoT, that is, there is a need to educate actors so that they are able to adopt and collaborate with the new institution (Binz et al., 2016; Wahid & Sein, 2014).

For the interviewees, not enough Educational actions are carried out to promote IoT as a management tool in cattle ranching in the state, neither by public nor private agencies. This fact is worrying, because, given the low ICT literacy of professionals who undertake for the rural sector and, mainly, of those who are on a daily basis on farms, they are unable to understand the benefits of using emerging technologies for the Vesting of knowledge and information about productive activities (Zhang et al., 2016).

The need to carry out Educational actions on this topic is known to all actors, including the federal public sector. As much as they say they still haven't taken action to remedy this problem, this has become a priority for them, so much so that, as mentioned in FPS02, in the action plan for 2021-2024, for the agro chamber 4.0, one of the priorities listed is "professional training, qualification and preparation of the workforce for the future". Therefore, these actions are necessary for a long-term change in the profile of professionals with an important role in disseminating and incorporating technologies in the rural environment (Zhang et al., 2016).

The empirical results of this study strengthen the Institutional Work theory by highlighting how specific practices are implemented in the agribusiness context to foster IoT adoption. By identifying practices such as Advocacy, Identity Building, and Normative Network Building, it was possible to demonstrate how concrete actions taken by institutional actors shape the organizational environment. These findings enrich the conceptual framework of the theory by offering practical examples of how institutional dynamics drive technological change in a sector that is traditionally resistant to innovation.

Final considerations

This study aimed to analyze how Institutional Work practices foster the adoption of the Internet of Things (IoT) in beef cattle in the state of Mato Grosso do Sul/Brazil. To achieve this objective, a qualitative, deductive and exploratory research was carried out, using a semi-structured interview and secondary data as a data collection technique. The interviews were conducted remotely using Google Meet, recorded with the respondents' permission and transcribed using the Transkriptor.com website. Empirical data were analyzed using Bardin 's (2009) content analysis technique. Coded using Institutional Work categories and subcategories and analyzed using the ATLAS.ti8® qualitative analysis software.

Institutional Work practices were identified as existing in the macro environment of the state of MS, namely Advocacy, Identity Construction, Normative Network Construction and R&D. Four practices were identified as partially existing, and two Institutional Work practices: Vesting and Educational, as non-existent in the MS macroenvironment.

The propositions raised were theoretically corroborated according to the empirical data analyzed. Proposition 1 was confirmed when observing that actions related to Advocacy and Defining were mentioned as existing, even if the second was partially mentioned, by the actors interviewed. Proposition 2 is confirmed, as Identity Construction, Changing Normative Associations and Constructing normative networks are carried out in some proportion in the macroenvironment of the state of MS. Finally, proposition 3 was also confirmed, however, not all practices were empirically observed, for example, Educational, was cited as non-existent by respondents, while the practices of Mimicry and Theorizing exist in a partial way.

Some of the contributions achieved by carrying out this study are linked to the theoretical field, such as, for example, adding empirical studies to the field of knowledge of IoT, agribusiness, and the theory of Institutional Work, topics that have rarely been addressed together. In addition, it expands on the work of Zarpelon et al. (2019) by addressing one of the suggestions for future research presented by the authors. As a contribution to practice, it is worth highlighting the detailing of the Institutional Work carried out in the state of MS, allowing federal, state, and private public actors to make conscious and efficient efforts to promote and structure IoT in the Brazilian agricultural sector. Some of these efforts to expand the adoption of this technology to rural areas may come from the creation of laws by the state and federal legislatures that foster important subsidies in line with the needs and desires of this sector. Another practical contribution is to allow livestock producers to have knowledge of and use IoT technologies, already available on the market, to improve their production processes.

As limitations of the research, there is no historical observation of the institutional change present in the field studied. The stage of institutionalization of IoT within beef cattle farming in the state of Mato Grosso do Sul is still incipient, with few Institutional Work actions carried out, therefore, it was decided to carry out a vertical study, without the intention of tracing a timeline. Another limitation of the study is that power, tension, pressure and resistance relationships were not observed in this research. The central concern turned to the actors, the actions of Institutional Work carried out and how they impact the promotion of the institutionalization of the studied technology.

Future studies can be carried out aiming to examine Institutional Work focused on IoT in other areas of cattle breeding, such as dairy, and in other agricultural activities such as agriculture. Finally, some points identified as results may indicate gaps for future research, among them: the gap between what technology develops in universities and its adoption in the practical world; low cooperation between actors that develop technologies; lack of government stimulus for the development of IoT projects and products; and low professional qualification for 4.0 technologies.

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Carrying out Institutional Work practices to promote the Internet of Things in beef cattle in the state of Mato Grosso do Sul/Brazil
Realización de prácticas de Trabajo Institucional para promover el Internet de las Cosas en la ganadería de carne en el estado de Mato Grosso do Sul/Brasil
Realização de práticas de Institutional Work para fomento da Internet das Coisas na pecuária bovina de corte no estado de Mato Grosso do Sul/Brasil

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