

Identifying effective institutions for China's circular economy: Bottom-up evidence from waste management

Waste Management & Research

1–10

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DOI: 10.1177/0734242X20972796

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Abstract

The present article centres on institutions, that is, systems of rules that guide behaviour and interaction of socio-economic actors, and their role in advancing China's circular economy (CE), particularly in waste management (WM). Since the early 2000s, state and non-state actors in China have begun to explore CE ideas in WM resulting in a multitude of related patterns and schemes. In regard to why such systems exhibit different degrees of effectiveness, it appears that much is determined by the institutional arrangements within. Based on several years of field research in China, the article identifies and analyses key institutional ingredients for effective outcomes. Methodologically, these components are identified via an analytical model incorporating WM performance indicators and a framework for assessing interest inclusiveness. Empirically, the analysis is applied to case study findings on the informal and semi-formalised recycling sector in Beijing and Changchun. The resulting findings are synthesised into an evaluation matrix: it indicates which effective informal institutional elements in waste collection and pre-processing allow for a translation into formal systems. The so-demonstrated convertibility indicates a substantial potential for the innovation of current formal WM systems in urban China.

Keywords

Circular economy, China, informal recycling sector, institutions, formalisation, waste collection

Received 23rd July 2020, accepted 14th October 2020 by Associate Editor Mario Grosso.

Introduction: the circular economy in China and the role of institutions

This year marks the 33rd anniversary of the Brundtland Report, which aimed at promoting global sustainable development through cooperative efforts among national stakeholders. So far, the struggle to reduce anthropogenic impacts on nature remains ineffective thus leaving little room for celebration. On the contrary, it very much seems that the necessary tools to curtail negative externalities of human thriving have either not been invented or are yet to be fully deployed. One of the more promising concepts to achieve remediation is the circular economy (CE). Originally centred on the 3R key notions (reduce-reuse-recycle), the essential idea is to redesign 'linear' economic operations into more sustainable, 'circular' structures. Key definitions depict the CE as 'restorative and regenerative by design, . . . to keep products, components, and materials at their highest utility and value at all times' (Moreau et al., 2017); wherein '[w]aste and resource use are minimised' (Pesce et al., 2020) to enable 'a continuous positive development cycle that preserves and enhances natural capital, optimises resource yields, and minimises system risks by managing finite stocks and renewable flows' (Moreau et al., 2017). The CE therefore 'involves re-modelling industrial systems along lines of ecosystems, recognising the efficiency of resource cycling in the natural environment' (Preston, 2012).

Next to the multitude of enthusiastic voices, the international discourse also underscores critical aspects of the CE, such as theoretical limitations or practical misuse. Korhonen et al. (2018), for example, elaborate on the limits of infinite material recycling, reuse, remanufacturing and refurbishment due to the natural boundaries set by entropy within a closed system such as earth. Others, such as Schulz and Lora-Wainwright (2019), highlight the potential danger of using the CE as a means of industrial reorganisation and control. They caution that the CE could serve as a political-ideological pretext for reallocating benefits exclusively to selected interest groups and thereby effectively marginalise weaker stakeholders. In expectation of effective results, the biased allocation of privileges to formal actor groups are an inherent vice in top-down implemented concepts. The present paper, however, shows that effective practices and structures pertaining to the CE also occur outside of the formal domain and that their integration requires relatively little effort.

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In search for effective applications of the CE, secondary research has been particularly emphatic about developments in the People's Republic of China. Given its spatial magnitude, the diversity in regional conditions and a highly experimental governance regime, China has since the early 2000s continuously trialled CE systems at various levels of scale. Due to systemic efforts, financial means and persistent government interest, the country became a leading player in the field, which gave rise to a distinctively Chinese CE development model (Geng and Doberstein, 2008; Ghisellini et al., 2016; Moreau et al., 2017). Forms of applications are plenty in nature and manifest in eco-industrial park development (Ghisellini et al., 2016; Mathews et al., 2018) as well as eco-city (de Jong et al., 2016) and eco-province (Wang et al., 2015) concepts. These achievements are to an essential degree dependent on tailor-made institutional structures, that is, systems of rules that structure interaction and behaviour of actors. This is not only true for 'the Chinese case in which institutions have exerted a significant impact on the creation of CE related industrial structures' (Moreau et al., 2017), but for CE applications globally (Boons et al., 2016; Ghisellini et al., 2016). Given the importance of institutions for China's CE, a key task for research is to identify which of these rule systems perform effectively and why.

Although various subfields of China's CE offer potential examples, this paper reviews field research evidence that the author gathered on the informal sector in China's urban recyclable waste collection. Research on this particular segment, its capacities and organisational structure, has increased over recent years (Fei et al., 2016; Gu et al., 2016; Tong and Tao, 2016; Xue et al., 2019; Yang et al., 2020); however, little attention has been given to why the informal recycling sector (IRS) manages to maintain its operations in urban China. Acknowledging the diversity of potential explanatory factors, the key argument here is that the IRS has secured its existence simply by trialling and maintaining effective rule systems. The central task of the present paper is to discern which elements render such bottom-up rule systems effective and to which extent they can be translated into more formal systems. For this purpose, the next section first presents an analytical model that outlines the premises for effective rule systems. In a subsequent step, the paper identifies elements of effective institutions from two projects on the IRS in China. Based on these concise findings, the analysis concludes by elaborating the potential for translating effective institutional elements to a more formal setting.

Materials and methods: analytical model

Reviewing the recent development trajectory of research activities in CE-related fields indicates that interdisciplinarity constitutes an increasingly important role, especially in regard to combining institutional with quantitative approaches. This is demonstrated by research contributions in the fields of industrial symbiosis (IS) as well as waste management (WM). As for

the former, analyses centring on institutional factors have received increasing emphasis in the context of modelling (Boons et al., 2016; Domenech and Davies, 2009). Moreover, institutional elements are often employed as supplementary analytic components for quantitative (Chertow and Lombardi, 2005; Jensen et al., 2011; van Berkel et al., 2009) as well as qualitative research (Cavalcanti Sá de Abreu and Ceglia 2018; Domenech and Davies, 2009) in the field of IS. In a similar fashion, work on WM systems, especially in the context of China, has made particular emphasis of institutional factors (Chung and Zhang, 2011; Steuer et al., 2018; Tong and Tao, 2016; Xue et al., 2019; Yu et al., 2010).

Against this backdrop, the present article employs a theoretical framework that analyses CE outcomes from an institutional economic perspective. Institutions are herein understood as systems of rules that structure behaviour and interaction of actors (Groenewegen et al., 2010). Institutions may be formal (codified rules such as regulations) or informal (individual patterns of behaviour such as routines) in nature. The objective of the following paragraphs is to delineate the context for the emergence of institutions, clarify the premises for institutional effectiveness and highlight the mechanisms for defusing effective institutions.

Institutional effectiveness is a concept developed by the author on the basis of ideas from the evolutionary institutional economics (Dosi and Nelson, 1994; Hodgson, 2004; Nelson and Winter, 1982) and with the aim to assess the performance of China's CE (Steuer 2018, 2020). From an institutional perspective, economic structures like the CE come into being and operate on the basis of rules, which determine structure, hierarchy and power relations within. Therefore, the chosen analytical scope is in essence dynamic, which by implication identifies a system like the CE as continuously evolving and unfolding along many simultaneous path trajectories. Herein, each path is constituted by an infinite, causal sequence of problem emergence and responsive institutional solution-finding (Mantzavinos, 2001). For each problem that occurs an institutional solution is devised and implemented, which in turn leads to the emergence of a subsequent, novel problem. The central mechanism or agency that deals with engaging the problem and finding a solution is constituted by the interplay of at least two contesting actor (decision-maker) groups. Equally affected by the emerging problem and essentially distinguished by the different interests they hold, these actors design and practise their own institutions to solve a problem. Central to this relationship is the element of contest or competition, which arises from the different interest preferences both sides pursue and ultimately aim to realise. Designing and implementing institutional solutions as well as spreading these within society essentially serve actor groups to attain this objective. The contest between both sides, as well as the degree to which implemented solutions solve the problem and how they are received and practised in society, generates an information and learning feedback to the actors. This feedback in turn informs and enhances the involved actors' decision-making process in the

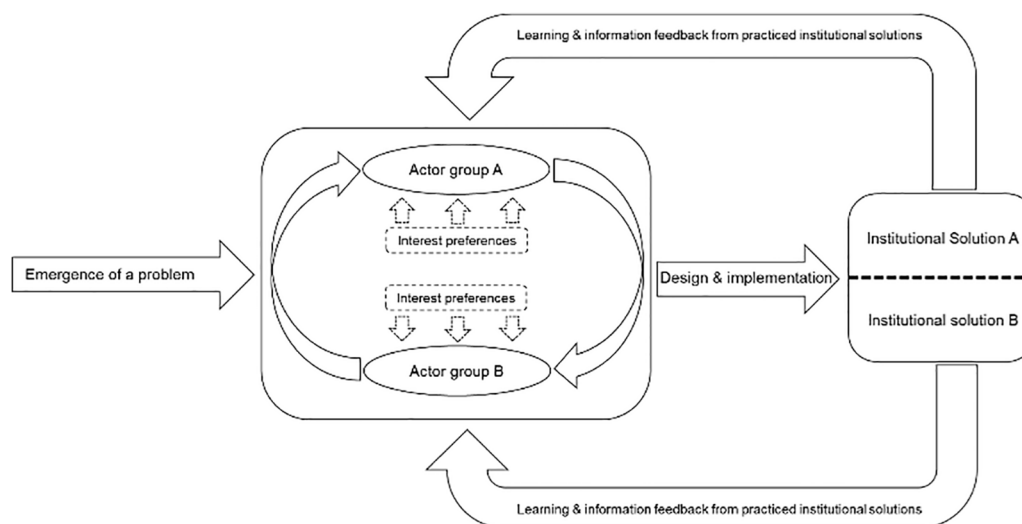


Figure 1. Institutional evolution through contesting actor interests and information feedbacks (based on Steuer, 2018).

subsequent cycle of problem emergence and solution-finding (Figure 1).

In order to arrive at effective institutional solutions two premises must hold. Firstly, an implemented institution needs to be able to technically solve the problem. For the case of waste collection and depending on the contextual benchmarks, it simply means that an institution is effective if it, for example, reduces randomly discarded waste piles or increases collection rates. It is important to note that this category of technical effectiveness can be evaluated via qualitative or quantitative indicators. A useful assessment tool in the context of WM is the waste triangle assessment framework that measures performance in environment-, cost- and service-related respects (Figure 2). Such types of frameworks that offer combinations of qualitative and quantitative elements facilitate the setting of benchmarks to define technical solution effectiveness.

The second premise of institutional effectiveness relates to the degree of interest inclusion. In this sense, an institution devised and practised by one actor group gains in effectiveness the more

actors or actor groups of the opposing side adhere to and practise it. Their motivation for doing so is that they perceive the institution as beneficial for realising their interests. Having achieved this level of acceptance, the institution is more likely to be practised over a sufficiently long time and by a sufficiently broad number of actors in society without being side-lined by alternative solutions from competing actor groups. The essential challenge for achieving this type of institutional effectiveness is that respective rule systems must satisfy two conditions. Firstly, the rule has to strike a balance between core interests of the involved actors. For the sake of simplicity, the interests are categorised as either economic or ecologic. Secondly, new rules need to conform to the principles of pre-existing institutional frameworks used by the involved actor groups.

In the case of China's WM, a framework based on these two dimensions of conditionality helps to position the involved key actors. Following a broad distinction, the IRS is located at the lower base and features a high degree of economic interest motivation and informality; at the middle tier are companies,

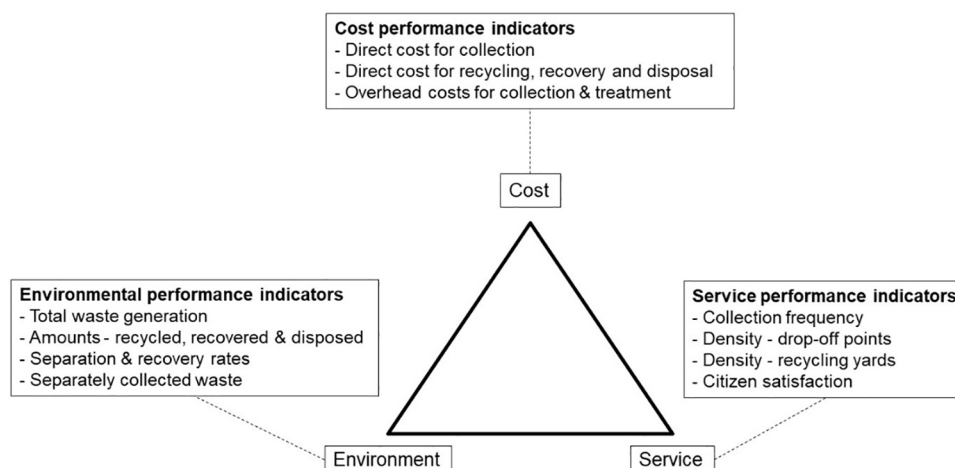


Figure 2. Waste triangle assessment framework (adapted from Goorhuis, 2014).

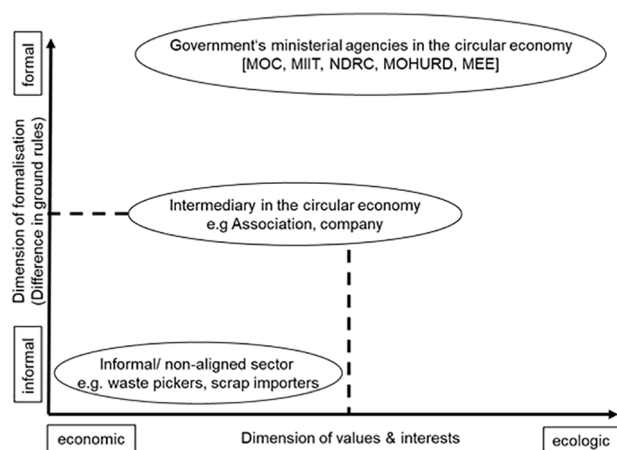


Figure 3. Two-dimensional context of interests and formalisation for actors in China's waste management. MEE: Ministry of Ecology and Environment; MIIT: Ministry of Industry and Information Technology; MOC: Ministry of Commerce; MOHURD: Ministry of Housing and Urban-Rural Development; NDRC: National Development and Reform Commission.

non-governmental organisations and non-profit organisations such as associations. They hold a broader array of interests spanning from economic to ecologic motives and adjust their operations to a higher level of formalisation. In addition, a multitude of governmental ministries is involved in China's WM system, which all operate on the very highest level of formalisation, while, however, pursuing a diverse array of different interests. This may in cases bear a theoretical potential for conflicts. For example, regulations devised by the Ministry of Ecology and Environment set forth very different key principles than those issued by the Ministry of Commerce (Steuer, 2018). For rule systems to effectively attain interest compromises, they need to feature the largest possible degree of congruence in interests and formalisation. Graphically, the framework suggests that the bigger the overlap in common interests and the shorter the distance in degrees of formalisation, the more likely it is that actors from one side devise and practise institutions that also benefit the other side (see Figure 3). This categorisation along two dimensions may in parts explain why past cases of IRS formalisation (i.e. the enforced cooperation between government and IRS) have not achieved lasting success (Steuer, 2018).

So, assuming that effective institutions exist and are practised, the remaining question then is how these rule systems diffuse within society? In this regard, the most pivotal mechanism is the process of learning from information feedbacks as seen in Figure

1. Essentially, the practice of a new rule will result in an outcome indicating how well a problem is solved (i.e. how effective the rule performed). This outcome can be captured in flows of information conveying quantitative and/or qualitative details of the resulting solution. The information is accessible for registration by the generator of the rule either by personal observation or through documentation from practitioners. Once accessed and evaluated, the information constitutes a learning feedback and in consequence helps in assessing whether the rule is effective and warrants continued practice, or if it is ineffective and should be discarded. For effective rules, there is a high probability of imitation by other actors, who deem it beneficial for their ends and therefore begin practising it. This dynamic essentially pinpoints to the broad process of effective rule diffusion. However, it should be noted that the complexity and diversity of real life often impedes a direct translation. Rather, what can be encountered is a mix of imitative and experimentative transfer of institutions. It implies a pattern, in which some rule elements assessed as key effective ingredients are copied, whereas other components are complemented through experimentation.

The following case studies on effective institutional systems centre on China's municipal solid waste collection, particularly on bottom-up-devised rule structures practised by the IRS. Despite being a product of the informal domain, the analysis shows that there exist theoretical and practical compatibilities with rule systems of the formal domain. It goes without saying that incorporating effective rules irrespective of their origins plays an essential role for the further development of China's WM and CE. The subsequent sections demonstrate that effective, bottom-up-devised institutions feature convincing elements of technical as well as interest-inclusive effectiveness.

Results and discussion: case study analysis

The effective, informal waste recovery system in Beijing

The first case of the IRS in Beijing was studied by the author and colleagues (see Acknowledgements) in 2013 and 2016. Initial field surveys covering nine subdistricts of Haidian district aimed to assess quantitative recovery performance, turnover and systemic set-up of informal waste collectors. Key findings indicated high collection rates and turnover levels achieved by the IRS (Table 1). A subsequent follow-up study in 2016 could further

Table 1. Collection rates of the informal recycling sector in Beijing (2013).

Informal recycling sector actor groups	n	Median collection (kg/cap/day)	Median reported turnover ^a (CNY/day)	Median calculated turnover ^b (CNY/day)
Waste pickers	25	16	1200	n.a.
Collectors with tricycle	54	311	2500	2711
Merchants with truck	19	890	5250	9379

^aReported turnover refers to figures provided by the interviewees.

^bCalculated turnover refers to the extrapolated sum of collected material quantity multiplied by respective material value.

n.a.: not available.

ascertain that the IRS reclaims around 90% of waste recyclables generated at household levels (Steuer et al., 2018).

These high recovery rates are mirrored in other studies on the IRS in China (Chen et al., 2018; Linzner and Salhofer, 2014), which leads to the question of what accounts for this performance. The answer derived from analyses of the Beijing case studies was that institutional factors constitute key determinants behind the achievements of the IRS. These include commonly routinised practices such as direct collection of recyclables at the doorstep of households, the establishment of personal contacts with residents, self-marketing services through the dissemination of business cards and cardboard signs providing contact number and lists of recyclables for take-back (Steuer et al., 2017, 2018). These elements feature strong institutional aspects pertaining to information exchange and learning, interest congruence and problem solution-finding as well as to WM performance indicators such as service provision, collection frequency and material recovery.

And yet these single-rule-related aspects turned out to be only a subordinate part of a larger institutional structure, which we termed the trading point (TP) system. These TPs resemble small marketplaces, where waste materials are delivered by collectors or residents and exchanged for money. At the receiving end, middle men then pre-process and further transfer materials to formal or informal recyclers. In their most basic form, TPs consist of a ground scale for weighing materials, a middle man who administers the exchange process and a truck to deliver the materials. More complex TPs stretch along entire streets hosted by middle men with individual, material-related specialisations. Based on extrapolations, we assessed that Beijing featured a network density with around one TP per 11,495 inhabitants in 2013.

In regard to the effectiveness criteria for institutional systems, TPs offered a wide range of benefits for the IRS. Technically, TPs bridged the transfer distance between waste generators (households) and recovery operations and refined the division of labour among the IRS, enabling specialisations in service and material focus. Their operation therefore effectively solved the problem of capturing waste quantities, channelling these into the reprocessing stage and finally refeeding secondary resources into the productive cycle. As for the factor of interest-inclusive effectiveness, the major benefit of TPs is the generation of profit for all involved actor groups. Through the increase in value along every instance of material exchange, generators, collectors and middle men would all make a profit from each unit of recyclable waste they exchange among each other. The entire procedure is facilitated by the high spatial density of points, inducing a habituation among IRS actors to prevalently frequent individually preferred TPs (Steuer et al., 2017). The so-outlined congruence in interest is of course limited. Interpreted on the basis of the analytical framework on interest congruence (Figure 3), the TP effectively serves the economic-centred interests of the IRS and of those households that feel more inclined towards economic rather than ecologic incentives. As for the difference in degrees of formalisation, the operations of TPs appear to fall within the array of what is acceptable for urban households, but not for the municipal

government. Officials have over many instances put substantial efforts into dispersing and prohibiting physical structures of the IRS, not least because of frequent instances of secondary pollution occurring at such sites (Tong and Tao, 2016). The reason for having allowed such structures in the first place was the lack in collection and recovery capacities of the formal domain during the 1980s and early 21st century (Li, 2002). Under these dire circumstances, IRS systems were deemed as helpful (effective) in reducing waste quantities and therefore served the interests of the formal domain. However, with the onset of modernising the WM system in recent years, the downsides of this system have apparently outweighed its benefits.

What confirms that the TP system and its key institutional components are effective is the degree of possibly unconscious imitation in urban China. Field surveys by the author in Guangzhou and Shenzhen revealed similar systems established by the local IRS. Over an approximate walking distance of 2.9 km (Guangzhou) to 3.4 km (Shenzhen) the author encountered several mobile waste collectors with tricycles, who when interviewed stated that they would either sell their recyclables to a formal transfer station or to a nearby TP, depending on respective price offers (personal communications, Guangzhou, Yuexiu district, November 2014 and Shenzhen, Futian district, March 2015). In both instances, TPs were identified in immediate proximity to the interviewees and interestingly these types of TPs were operating within buildings and not under open air. In Shenzhen (see Figure 4), the interviewed middle man indicated that such a more formal setting was the preferred choice given the requirements of the municipal government. Provided that the middle man would prevent environmental pollution and safeguard a clean appearance of the TP's surroundings, local administrators would turn a blind eye on his 'informal' activities (personal communication, Shenzhen, Futian district, 12 March 2015). Presumably, this kind of arrangement stemmed from a compromise in interests. Local administrators may have seen the benefits of such structures for facilitating waste recovery and reducing the load for landfills. For informal actors the main driver appeared to be the economic turnover. Despite the replication of informal TPs in Guangzhou and Shenzhen, providing evidence for effectiveness, the Beijing government strived to develop a more formalised take-back point system. The main measure trialled in many Beijing communities in 2008 was to install collection booths within residential quarters. However, low remuneration and rigid material transfer channels side-lined the interests of involved non-state actors (Tong and Tao, 2016) and impeded a successful formal emulation of the TP system.

The effective semi-formalised waste recovery system in Changchun

Attempts to formalise the IRS are not uncommon in China; however, most instances have met with failure. Procedures often started out successfully, but in many instances the schemes seemed to have incurred conflicts of interest, particularly pertaining to the division of profits from recovery operations, leading



Figure 4. Surveyed area in Shenzhen. Stars indicate encountered waste collectors; the hexagon indicates the location of a TP (based on maps.baidu.com).

ultimately to their cancellation (Steuer, 2018). However, as the following paragraphs present, there are ways of IRS formalisation that can produce effective, sustainable outcomes.

The institutional innovation discussed in this section was observed in Changchun city over the course of an ongoing research project (see Acknowledgements) on a novel waste collection scheme called ant recovery (AR) (mayi huishou 蚂蚁回收). This initiative is the brainchild of the local recycling association in Changchun and its subsidiary migrant worker association, which is mostly composed of labour migrants (70%) working in waste processing. Active since 2017, the platform's major achievement was to absorb informally operating waste buyers and reorganise them under the formal umbrella of AR (personal communication with Dr Li Huijie, July 2020). A beneficial dynamic for this scheme comes from the national household waste separation campaign, which has since 2017 provided a strong impetus for local waste recovery activities (Steuer, 2020). In response, the Changchun municipality has like many other cities issued its own household waste separation regulation. It stipulates the option for the government to outsource recovery tasks to private service providers obliging them to reclaim household waste from residents, ideally at the doorstep level (Changchun Government Working Office, 2018). AR took over this role in some districts and was officially designated as a pilot in 2018.

By then, AR's network included 100 trucks in selected areas – labelled as mobile collection points and served by intermediary buyers – with a designated service coverage of approximately 4000 households per point (Solidwaste, 2018). As of 2020, the pilot expanded to overall 600 mobile collection points (personal communication with Dr Li Huijie, July 2020) and is studied and emulated by governments in Beijing and Dalian (Epaper, 2018). In terms of performance, preliminary field research findings indicated that one mobile collection point of AR achieves median recovery rates of 436 kg/h delivered by approximately 29 residents, street cleaners and informal collectors. Based on the observation that recyclables were transferred to the surveyed point for around 7 h every day, a daily recovery median of around 3052 kg can be extrapolated. Assuming that this collection point lies within the average performance range of the scheme's overall 600 units, AR may in theory reclaim as much as 1831 metric tonnes, equalling 80% of the estimated 2283 metric tonnes of waste recyclables generated by the city's households everyday (Bureau of Ecology and Environment of Changchun, 2018; China Resource Recycling Association, 2018).

The formalised model scheme adopted in Changchun features evident similarities to the first case study in Beijing (e.g. collection points managed by middle men with a truck, who pay for delivered waste recyclables). Yet the fact that it constitutes a formalised system implies a more effective alignment of the competing interests within. Under the scheme, formerly informal actors, for example, are allowed to retain their turnover and the government does not levy any fees. Material buying prices are determined on the basis of market developments within moderately flexible margins. The implementation of the pricing mechanism resulted from considerations regarding potential competition with the IRS and to prevent abnormal profit-making. On the one hand, AR provides buyers with relative flexibility in setting their prices. Allowing large profit margins was thought to help retain competitiveness with the IRS. So, in order to incentivise informal waste buyers to join AR, the scheme grants collection points the freedom to determine prices individually based on market demand. On the other hand, AR has also set forth 'soft' (i.e. indicative) price margins to prevent abnormal profit-making by individual collection points. This step aims at preventing individual points from exploiting potential take-back monopolies in less contested areas. Yet, the margin caps are not binding and are set flexibly in accord with changes in market prices, which are essentially determined by waste processing facilities downstream. In addition, the pricing mechanism is also influenced by the preference of the residents, who in face of low prices set by one collection point might simply opt to choose returning waste recyclables to another point (personal communication with Dr Li Huijie, email, September 2020 and with Mr Deng Guangbiao, Changchun, April 2019).

The requirements for AR set forth by the government were relatively moderate. The municipality specified a particular spatial network plan that stipulates a coverage range of 4000 households per mobile collection point. Another official standard came

Table 2. Trading point system of Beijing (2013–2016).

Performance elements	Documented criteria	Intermediary buyers' interests	Government interests
Turnover of collector	Improved/safeguarded by the system	+	~
Fees	Not charged by officials	+	-
Material prices	Arbitrary (market-based)	+	~
Coverage network	Entire subdistricts	+	+
Recovery mode	Informal recycling sector and residents deliver	+	~
Locations	Random	+	-
Service provision	Take-back and further delivery	~	+
Formalisation requirements	None	+	-
Environmental standards	No prevention of secondary pollution at the collection site	~	-
System expansion	Market-driven and regulatory leeway	+	-
System acceptance	Trading points perceived as nuisance by residents/officials	-	-

+ indicates beneficial; ~ indicates indifferent; - indicates adverse.

Table 3. Ant recovery system of Changchun (2018/19–).

Performance elements	Documented criteria	Intermediary buyers' interests	Government interests
Turnover of collector	Improved/safeguarded by the system	+	~
Fees	Not charged by officials	+	-
Material prices	Market-based, with caps	~	+
Coverage network	Entire subdistricts (planned)	+	+
Recovery mode	Delivery by residents predominates	+	+
Locations	Administrative allocation	-	+
Service provision	Take-back and further delivery	~	+
Formalisation requirements	Appearance and procedures	-	+
Environmental standards	Prevention of secondary pollution at the collection site	~	+
System expansion	Administrative coordination	~	+
System acceptance	Collection points are accepted by residents/officials	+	+

+ indicates beneficial; ~ indicates indifferent; - indicates adverse.

in the form of three designations referring to time, area and vehicles for waste collection. To render operations formal with respect to optical standards, governmental regulations further stipulated the need to unify vehicle type and labelling, working attire and ground scales. Similarly, service performance was standardised in terms of provision and standards as well as business conduct (Epaper, 2018). During field investigations, the author and colleagues surveyed one demonstration point over several consecutive weeks and found these requirements by and large fulfilled. The vehicle carried the official AR logo and waste recyclable transactions were conducted in a manner transparent for residents. Prices were indicated upon request, transferred materials were scaled and compensation was provided to delivering actors on the basis of weight and fraction price. Further interviews with the involved parties (i.e. residents, middle men and administrative personnel) indicated that the system has apparently achieved a viable congruence in interests. Interviewed middle men did not perceive that their turnover was negatively affected by the scheme, but rather indicated that formalisation increased trust among residents towards their operations. Residents in turn felt the system to be convenient, less unorderedly

than the previous informal mode and more reliable in terms of compensation. Moreover, governmental actors praised the service quality and appearance of AR, which arguably complied better with the local governance ideals of a modern Chinese city.

Identifying institutional effectiveness: a case study-based comparison

As both cases demonstrate, informal or semi-formalised systems bear substantial potential for innovation in Chinese WM. In order to trace effective institutions and the elements suitable for replication, a performance indicator matrix is used for assessing the systems of both case studies (Tables 2 and 3). Based on common characteristics (performance elements), these systems are evaluated with respect to technical and interest-inclusive effectiveness. The assessment puts particular emphasis on the latter factor for the two main actor groups (i.e. intermediary buyers of the IRS/AR and the government). This is essential as past efforts to set up institutional structures involving both sides failed due to repeated occurrences of interest imbalances. In order to gauge this factor, a simple tripartite evaluation scheme is used to categorise

institutional elements as beneficial (+), indifferent (~) or adverse (–) to the interests of each actor group.

As AR has achieved a remarkable balance in interests and thereby fulfilled the respective institutional effectiveness premise, it is worthwhile to analyse the key elements of this scheme. Firstly, AR retains two concepts of IRS schemes, which is to allow buyers to keep turnovers and to prevent the payment of fees. As documented in secondary literature, the imposition of the latter had previously induced other formalisation approaches by the government to fail (Steuer, 2018). As for material prices, these are made subject to ‘soft’ controls in AR’s scheme. This favours governmental interest to regulate excessive profit-making and may slightly reduce the profit margin of intermediary buyers. A more substantial difference between the systems pertains to the recovery mode. For intermediary buyers, obtaining sufficient material quantities is a key factor, no matter how these are obtained. For the government, AR’s approach presents an advantage for several reasons. Firstly, AR is tasked with collecting, sorting and documenting secondary material quantities, which in turn increases transparency and facilitates the coordination of downstream processes by the government. Secondly, residents are incentivised to deliver waste recyclables to AR collection points (‘cash for trash’), which renders costly (official) promotion campaigns unnecessary. Finally, the direct transaction of materials from residents to intermediary buyers reduces the involvement of IRS collectors, who seem to play only a minor role in Changchun’s AR (personal observations and interviews by the author, Changchun, April 2019). This again is clearly in the interest of the local government.

Minor burdens for AR’s intermediary buyers arise from the features of location and formalisation requirements. The former may potentially harm the interest of buyers, should they feel they have been allocated to locations that are difficult to access or too far away from residents’ homes or if the location in any other way impairs their profits. Indeed, assigning areas to intermediary buyers constitutes a potential pitfall as these actors normally operate within areas that they have grown familiar with. So, although it is in the interest of the government to administratively allocate locations and thus enhance supervision over collection points, insufficient profit-making by intermediary buyers in less frequented areas may put parts of the system into jeopardy. In a similar fashion, formalisation requirements absent in Beijing’s purely informal system are somewhat suboptimal for ant recovery (AC)’s buyers as they entail additional expenditures for standardised clothing and vehicle labelling. For the government on the other hand, such standards are a basic must for a system it entrusts with formal waste recyclable collection. The improvement of environmental standards in AC’s scheme (i.e. the prevention of secondary pollution) can be seen as another positive for the government. Frequently perceived by municipalities as a major problem when dealing with the IRS (Fei et al., 2016; Tong and Tao, 2016), Changchun’s AR requires its participants to clean their collection site at regular intervals. The measure is clearly in line with official preferences for a clean urban environment

– loosely expressed in the ecological civilisation governance concept. Yet from the perspective of one intermediary buyer, this activity requires relatively little effort and merely constitutes a minor burden (personal communication with Mr Wang, Changchun, April 2019).

The element of system expansion pertains to the mechanisms of operational growth of the scheme. In the Beijing case, the IRS expanded its operation on the basis of market demand and existing regulatory leeway. Although this served IRS interests in instances of weak formal control, such patterns have been a major challenge for Beijing’s government. The expansion of Changchun’s scheme on the other hand returns control and management over the scheme to officials and clearly accommodates their interest. Intermediary buyers therefore must adjust operations to formal decision-making. However, given that the scheme deploys a network structure in which each collection point serves around 4000 households it can be assumed that AR stakeholders are rather indifferent than opposed to this approach. Finally, the element of system acceptance is evaluated differently in the two cases. In Beijing, TP structures frequently fell victim to official expulsion and disapproval from residents. Thereof emerging conflicts between authorities and the IRS are not in the interest of either party. In Changchun, however, the formalisation process essentially boosted the legitimacy of operations at collection points. Apart from the official acknowledgement of AR as a formal pilot, its approval has also been expressed by residents and waste buyers. By implication the operation of the scheme has gained massively in public and official trust and thus in stability.

Conclusion

The article presents two cases of institutional arrangements in China’s urban WM, which are bottom-up devised by actors of the IRS and feature notable degrees of institutional effectiveness. As specified by the analytical model, institutional effectiveness is a rule-specific quality that indicates the capacity to technically solve a problem and simultaneously serve the most fundamental interests of all affected actor groups. The essential key findings from both cases are twofold. Not only has the IRS developed its own institutions to effectively recover recyclable waste from households, but the IRS rule structures also bear the potential for formalisation without necessary reductions in effectiveness. These are significant results for the following reasons. Firstly, there is increasing interest in the informal sector and secondary literature has for some time been discussing options for its integration into the formal system (Chen et al., 2018; Fei et al., 2016; Gu et al., 2016; Xue et al., 2019; Yang et al., 2020). The analysis in this paper has shown that there are indeed ways to integrate the IRS within a semi-formalised scheme. This assessment in turn bears important insights for the future of China’s CE. Given the recent policy trajectory, it can be assumed that the CE will continue to play an important role in China. However, because of the country’s comparative advancement in the field and due to the absence of a guiding blueprint, the main challenge lies in

identifying effective rule systems to further advance the CE development. Apart from top-down policy experimentation, the replication of effective bottom-up schemes may just prove to be one viable option along this way.

AR exemplifies a bottom-up scheme that fulfils both preconditions of effective institutions and therefore constitutes a case for further replication. It effectively reclaims waste materials from urban households and at the same time serves the interests of involved intermediary buyers as well as official stakeholders. Herein, the key innovation is the achievement of a balance in interests: a factor frequently side-lined in past (failed) formalisation efforts, yet pivotal for generating effective innovations in urban China's future WM governance.

Acknowledgements

The author expresses gratitude to Professor Stefan Petrus Salhofer (University of Natural Resources and Applied Life Sciences, Vienna) and Dr Roland Ramusch (European Bank for Reconstruction and Development), who provided means and ideas for enabling research on the IRS in Beijing. Additionally, major thanks go to Dr Li Huijie (Jilin University), who facilitated and joined the field research in Changchun.

Declaration of conflicting interests

The author declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: Research on the IRS in Beijing received financial support from the Funds of the Austrian Central Bank: 'Invisible hands? – informal employment in the service of resource efficiency in urban China', Anniversary Fund (project number 15325); and 'Invisible markets – the role of households and waste collectors for resource management in urban China, Beijing', Anniversary Fund (project number 16763). Research on the IRS in Changchun received financial support from the National Social Science Fund of the People's Republic of China for Young Scholars (grant number 18CZZ010).

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