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可持续发展与社会共治：电子商务纸包装的现状、影响与建议

Sustainable Development and Social Common Governance : State, Environmental Impact and Perspectives of Paper Packaging in E-commerce Consumption

复旦发展研究院、锦江麦德龙现购自运有限公司
Fudan Development Institute、METRO China Co., Ltd

可持续发展与社会共治：

电子商务纸包装的现状、影响与建议

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“Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs. It contains within it two key concepts: The concept of 'needs', in particular, the essential needs of the world's poor, to which overriding priority should be given; and the idea of limitations imposed by the state of technology and social organization on the environment's ability to meet present and future needs.”

— World Commission on Environment and Development, Our Common Future (1987)

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引言

本报告展示了过度纸制品包装问题的存在现状和其所带来的潜在环境危害，并进一步就可能的解决方案进行探讨。从国内外电子商务消费领域的发展现状切入，尝试了解目前在该领域中常用的纸制品包装的生产和消费现状和发展趋势；同时，对这一特定类型的纸制品包装所可能存在的各项潜在环境影响的研究进展进行了梳理和总结；另外，通过对相关行业产业关键意见领袖进行深度访谈采集专家意见和论点，尝试提取出目前针对这一议题的各项主要行业发展方向和未来研究关注点；同时，对目前国内外的相关政策制定以及优秀的实践案例进行了回顾和总结；最后，通过整合以上四部分的调研内容，以国内外电子商务消费领域中常用纸制品包装的现状和发展趋势为基础，全方位考量这一特定类型的纸制品包装的各项潜在环境影响，结合行业与研究领域中的专家意见并参考其他国家及地区现行的优秀案例，对我国目前的电子商务消费领域中的过度纸制品包装问题提出展望和可行性建议。

近年来，我国电子商务行业发展迅速，快递物流行业作为电子商务行业的重要支撑同步兴起。据国家邮政局统计，2018 年我国累计发送 500 亿件快件，消耗包装箱约 143 亿个、编织袋约 53 亿条、塑料袋约 245 亿个、封套 57 亿个和胶带约 430 亿米。在商品的流通中，产品外包装具有保护商品、美化商品、便于储运、引导消费、提高附加值等作用(Zhai et al., 2010)。然而，随着生产者与消费者对包装要求的逐渐提高，“过度包装”问题也日趋严重。“过度”可以体现在耗材、分量、体积、成本等几个方面，大致可以分为商品过度包装和物流过度包装两个方面。但针对于过度包装，却很难做出精确的概念界定，它是与适度包装(同样难以精确界定)相对而言的。Bi(2008)对适度包装的定义解释为，是指一种合理而合适的商品包装，及保护功能得当、使用材料适宜、体积容量适量、费用成本合理、标识标签完整。国家质检总局和国家标准委在 2010 年发布的国家标准《限制商品过度包装要求 食品和化妆品》中，在食品与化妆品领域对过度包装给出了相对可量化的指导标准。《标准》指出，过度包装(excessive

package)是指超出正常的包装功能需求，其包装空隙率、包装层数、包装成本超过必要程度的包装。《标准》对饮料酒、糕点、茶叶、粮食、化妆品等的包装提出的限量指标。例如，茶叶的包装空隙率不得高于 25%、包装层数不得高于 3 层、除初始包装之外所有包装成本的总和不宜超过商品销售价格的 12%。然而，国家对于其他商品的包装标准相对缺失，而针对于快速兴起的物流行业的二次包装，相关标准更为不足。

过度包装会产生诸多危害，主要可以归纳为四个方面。一方面，过度的包装造成极大的资源浪费。包装行业的原材料主要有纸、玻璃、塑料、金属等，而这些材料的生产则来源于树木、石油、钢铁等，过度的包装再加上不能有效的回收，在一定程度上浪费了资源。另一方面，未能有效回收包装废弃物加重了对环境的污染。根据多家媒体报道，我国的生活垃圾 2017 年产量突破 4 亿吨，还在逐年上升。包装废弃物占到生活固废的三成左右(Zhou, 2009),而每年生活固废的产生量和处理量之间存在巨大缺口,这就造成了存量堆积，对生态环境造成巨大影响。再者，商品的过度包装侵害了消费者的利益。在支付了必要的商品价格后，消费者承担了额外的巨额包装费。这个巨额包装费不仅包含过度包装的部分，而且包含了包装制品上游原料加工、生产、运输、一系列向下传导来的费用。最后，过度包装诱发社会不良风气，暗藏腐败行为。过度包装的节日礼品经常成为行贿者的“遮羞布”，利用包装内多余空间暗藏高价值的物品。

在所有的包装制品品类中，纸制品包装产值占到包装行业总产值的四成以上(CHYXX, 2017)。电子商务领域和物流运输领域飞速发展，人们对网购的依赖性也日益增强，仅 2017 年，中国快递业务量达 400 多亿件，同比增长 28%，占据世界份额超过 40%，纸制品的包装的供应量和需求量空前的巨大。而目前我国纸制品的回收率不及 50%，远低于世界较发达国家的水平(Chinabaogao, 2017)。未经回收的纸制品是极大的资源浪费，不仅如此，纸制包装的加工生产流程对环境污染严重，这种资源浪费直接导致的就是造纸行业上游产业的环境破坏。

环境及资源具有公共物品属性，关乎全人类的利益与未来发展，而人类的发展又对环境产生巨大压力，如何能有效的达到二者间的平衡，才是值得关注的问题。不难看出，当今电子商务领域的兴起与飞速发展，已经开始大量消耗环境资源，并且在这样的发展趋势下，巨大的潜在环境危害正在一步步逼近。因此，就电子商务领域中的过度纸制品包装对环境产生的影响进行全面的了解和深刻的认识，并提出适用于当下的可行的解决方案是十分必要的。**值得注意的是，电子商务领域的范围较广，其中所涉及到的纸制品包装利用的种类繁多，首先对占比最重问题最为显著的纸制品包装——快递行业中的纸制品包装进行探究的意义更为重大，因此，本文中将快递行业中的纸制品包装作为主要对象进行阐述。**就产业链来说，快递行业中的纸制品包装出现在了多个环节当中，主要包括三个阶段：1）纸制品包装产品的生产阶段，即从原材料到成品；2）纸制品包装产品在快递物流运输过程中的使用，即第三方供货商（例如电商平台，零售商，个人等）对纸制品包装产品的使用；3）纸制品包装产品到达终端消费者处，即电商消费者最终获取所购买的物品以及纸制品包装产品，并对纸制品包装产品的末端处理。这三个阶段分别会产生不同的环境影响，包括资源消耗以及污染排放，考虑到本文的主要对象为纸制品包装本身，因此将着重就第一阶段的生产以及第三阶段的回收利用进行探究，而在第二阶段由于所涉及到物流及仓储，将以专家访谈的形式进行研究并整理。

1. 趋势 - 电子商务消费领域纸制品包装现状

1.1 电子商务消费现状

1.1.1 国际现状

从全球环境看，电子商务市场在十多年间保持了中快速的增长，并且这种增长势头仍在继续。目前全球网民数已经达到 41.6 亿人，亚洲网民数量就占半壁江山；而发达国家和地区虽然互联网覆盖率较高，但网民增速相对比较低(CEICC, 2018)。根据 Internet World Stats 的数据统计，全球共有七个国家网民数过亿人，分别是中国、印度、美国、巴西、印度尼西亚、日本、和俄罗斯(Internet World Stats, 2018)。得益于巨大网民基数红利，2017 年仅零售类电子商务交易总额就突破了 2.3 万亿美元，同比上涨了 21%，据预测这个交易总量会在 2021 年实现翻番 (Orendorff, 2017)；相对地，2017 年全球零售交易总额为 22.6 万亿美元，同比上涨 5.8%，电子商务零售额占全球零售总额的比重由 8.6%（2016 年）上升至 10.2%（2017 年）。网络零售在社会整体零售中的重要性逐年提高(商务部，2017)。Orendorff 的统计同样显示，目前电子商务市场规模最大的是中国($672 billion)，然后是美国、英国、日本、和德国等(2017)。然而，全球单子商务市场的增长速度，除几个新兴市场外，均出现了放缓的趋势，主要是因为互联网用户增速下降、产业的增长空间和潜力受到限制（表 1.1.1-1）。

表 1.1.1-1：2016-2021 年全球零售及电子商务相关数据及预测

年份	总零售额（万亿美元）	增速	网络零售额（万亿美元）	增速	网络零售占比
2021e	27.920	4.90%	4.878	18.00%	17.50%
2020e	26.610	5.30%	4.135	19.80%	15.50%
2019e	25.271	5.50%	3.453	21.50%	13.70%
2018e	23.946	5.80%	2.842	23.30%	11.90%
2017	22.640	5.80%	2.304	24.80%	10.20%
2016	21.396	5.20%	1.845	25.60%	8.60%

表 e 年份为预测值

不同国家和地区的电子商务发展各具特色：

美国是电子商务发展最早且最成熟的国家，不仅产生了几大世界级的电商平台，例如亚马逊、苹果、和沃尔玛，还有著名的“黑色星期五”等促销节日为网购掀起狂欢，数据显示，美国 2017 年网络总零售额达到 4520.76 亿美元，同比增长 15.9%，位于世界第二，其网络零售额占到美国全年零售总额的 8.9%(商务部，2017)；中国则是全球规模最大且最具活力的电子商务市场，近几年的“双十一”更是连续创造了日成交量的奇迹；英国是欧洲最大的电子商务市场，互联网普及率达到 90%以上，电子商务销售额超过 GDP 的 7%；日本和韩国 B2B 和 B2C 电子商务年交易规模均占 GDP 的半数以上(60%，80%)；拉丁美洲则是最受欢迎电子商务新兴市场，从 2016 年开始，巴西跃居拉美电子商务市场第一位；从网购人数的增长区域来看，中东和非洲将是未来几年电子商务市场发展最新活力(CEICC, 2018)。虽然全球电子商务发展放缓，但是由新的技术推动的新业态和新模式层出不穷，因此，电子商务领域的发展也渐渐从粗放式生长进入到集约式和精细化的增长阶段。

跨境电商取得的成绩同样备受瞩目。随着人们购买力的提高，对商品的质量、性价比、品牌、多样性的需求也更加旺盛，“海淘”市场在全世界范围内扩大。根据联合国贸易暨发展会议(UNCTAD)的研究预测，2018 年全球跨境电商交易额将突破 6700 亿美元，而到 2020 年将有望突破万亿美元(UNCTAD, 2016)。从地区上看，欧洲是世界上最大的跨境电子商务市场，美国的跨境电商发展则相对滞后；加拿大、墨西哥、韩国三个国家有半数以上的电商交易是与美国达成，而美国、巴西、俄罗斯、和匈牙利则有半数以上的跨境电商交易与中国达成(IPC, 2018)；IPC(2018)同时发现，前五大跨境购买的产品中，服装类占到最高的比重(30%)，紧跟着消费性电子产品(19%)、健康品和美容品(14%)、书籍和音像制品(10%)、珠宝首饰(9%)。2017 年，我国跨境电子商务继续保持快速发展态势，跨境网络零售增长迅速。海关统计显示，2017 年中国海关验放的跨境电商进出口额为 902.4 亿元，同比增长 80.6%，其中出口 336.5 亿元，进口

为 565.9 亿元，同比分别增长了 41.3%和 120%。近三年中国海关跨境电商零售进出口额年均增长率在 50%以上(商务部，2017)电子商务的无国界化不仅直接的促进了线上与线下的融合、模糊了产业的边界、打造了众多无边界企业，更间接的提升了贸易的平等、创造了工作机会、共享了更多的资源。

1.1.2 国内现状

2017 年，习近平总书记在十九大报告中多次提及互联网，彰显了互联网在经济社会发展中的重要地位。近年来，从信息化的普及，到互联网助力传统企业的转型升级，再到互联网、大数据、人工智能的深度融合，我国借助互联网红利，实现了飞速的经济发展。互联网模式不断创新、线上线下服务融合加速、再加上公共服务线上化的步幅加快，使中国的网民规模也保持持续且稳定的增长。根据中国互联网络信息中心最新发布的《第 41 次中国互联网络发展状况统计报告》显示，截至 2017 年 12 月，中国网民规模达到 7.72 亿人，普及率达到 55.8%；手机网民规模达到 7.53 亿，使用手机上网人群占比提升至 97.5%(CNNIC, 2018)。



图 1.1.2-1：2011-2017 中国电子商务交易总额及增长率

在良好的互联网大环境下，线上支付工具不断发展，线上线下纵深融合，使得我国电子商务领域得到蓬勃的发展。目前我国网络购物用户规模超过 5.3 亿(包含网上外卖用户 3.4 亿)，2017 年我国电商交易总额达到 29.2 万亿元人民币(CEICC, 2018)，同比上升 11.7%，虽近年来增速有所放缓，但整体上涨趋势不变(见图 1.1.2-1)。仅仅网络零售行业交易金额在 2017 年就达到将近 7.2 万亿元，同比增长 32.2% (见图 1.1.2-2)(CNNIC, 2018)。实物商品网络零售额约 5.5 万亿元，占网络零售交易总额的 76.3%，同比年增长率 28.0%，占社会零售总额的 15.0% (商务部，2017)。



图 1.1.2-2：2011-2017 年中国网上零售交易规模

电子商务领域的服务模式创新和技术形态创新层出不穷，不仅出现了大量的无人值守的便利店、餐厅、和办公室货架，同时，移动支付和刷脸支付也使这些便利成为了常态。对于传统业态，电子商务同样起到了赋能的作用，例如通过 AR 技术实现的虚拟试衣间，就有效推动了线下实体商业的升级，提高了交易量。

相关法律法规的制定与完善，以及国家政策的支持，同样为电子商务的发展保驾护航。2018 年 6 月《电子商务法》草案吸纳广泛意见后被提交全国人大常委会第三次次审议，其中就包含了重新定义“电子商务经营者”(涵盖了我们熟知的微商)，法律后期通过后有望填补领域中的诸多空白(SOHU, 2018)。另外，《网络安全法》和一些相关的互联网信息管理规定，为网络信息(包括个人信息)提供了法律保障，净化了网络环境。再者，国家发改委发出的《关于推动电子商务发展有关工作的通知》，将在 17 城市创建国家电子商务示范城市(Lin, 2017)，这不仅极大的促进了地方经济，扶持了众多电商企业、物流企业、以及零售商，又为电子商务未来的发展积累了宝贵经验。

1.2 纸制品包装产业现状

中国现代造纸行业从改革开放后实现真正起步，在国家政策和资金的支持下，造纸业取得了跨越式的发展。经过几十年的发展，中国从 2007 年开始脱离进口依赖，基本实现国内的供给平衡；从 2009 年开始，中国开始连续成为纸和纸板全球最大的生产国和消费国(CHYXX, 2018)；2017 年，中国规模以上造纸生产企业约为 2800 家左右，全国纸及纸板生产量超过 1.1 亿吨(东部 11 个省产量占比 74.9%)，消费量与生产量基本持平，人均年消费量 78 千克(China Paper Association, 2018)。近几年，国家实施供给侧改革，淘汰落后产能，在日趋严格的环保压力下，造纸行业与其他传统制造业一样，均受到一定的冲击。然而，随着行业的规范化、集中度的提高，以及下游产业例如电子商务的蓬勃发展，造纸行业维持了相对稳定的增长态势，在包装用纸领域甚至出现轻微供不应求。

在纸质产品的众多应用中，包装用纸占据该产业的绝对领先位置。包装用纸的生产有很大部分是以废纸为生产原材料的，生成的二次利用产品主要包括白板纸、箱板纸、和瓦楞原纸。白板纸是原纸板经过单面涂布白色涂料后经由机器制成的纸板，在单面进行彩色印刷后一般用于制作包装盒；箱板纸又称为牛皮纸或牛卡纸，主要用于与瓦楞原纸粘合制作瓦楞纸板；瓦楞原纸又称为瓦楞纸芯，是瓦楞纸板中间层的波纹状芯，由于其结构有抗震作用，多制成瓦楞纸箱作为下游产品的外包装。根据《中国造纸行业 2017 年度报告》显示，在 2017 年，整个包装用纸的生产总量和消费总量分别为 6845 万吨和 6972 万吨，占整个造纸行业的 61.4%和 63.4%；其中，箱板纸和瓦楞原纸又构成纸制包装生产和消费的主要元素，二者的生产量和消费量基本保持同一水平，加在一起共占到包装纸类的七成左右；白板纸 2017 年生产量 1430 万吨，略高于其消费量 1299 万吨(China Paper Association, 2018)。其他相关数据请参考表 1.2-1：

表 1.2-1：各类别包装用纸生产总量和消费总量

品种	生产量 2017 (万吨)	同比增长 (%)	消费量 2017 (万吨)	同比增长 (%)	进口量 2017 (万吨)	出口量 2017 (万吨)
包装用纸总量	6845	2.85	6912	4.90	278	220
白板纸	1430	1.78	1299	2.69	62	193
箱板纸	2385	3.47	2510	6.18	137	12
瓦楞原纸	2335	2.86	2396	5.50	65	4
其他包装纸	695	2.96	707	2.61	23	11

废纸作为包装用纸的主要原料，其来源途径主要为本国回收和国外进口。根据《2017-2022 年中国废纸再生利用产业运营现状及发展前景分析报告》显示，中国近年来的废纸年回收量已经达到 5000 万吨左右，冠于亚洲和全球其他国家(Chinabaogao, 2017)。但这极大地得益于中国的人口基数，实际的回收率仍落后于较发达的国家。根据上述报告给出的计算公式计算：

$$\text{废纸回收率} = \frac{\textit{废纸国内回收量}(\textit{纸厂废纸采购量}+\textit{废纸出口量}-\textit{废纸进口量})}{\textit{纸和纸板国内消费量}(\textit{纸厂纸和纸板销售量}-\textit{纸和纸板出口量}+\textit{纸和纸板进口量})}$$

中国的废纸回收率到目前为止还不足 50%，远低于世界前三的韩国(90%)、法国(82%)、和日本(79%)(Chinabaogao, 2017)。从“十二五”开始，我国造纸产业结构调整，以废纸为原料的新建项目增多，规模增大，从而使废纸的回收利用效率得以提高。目前我国的废纸回收效率已经增长到接近芬兰和瑞典，废纸利用效率也达到世界较高水平(72%)(Bojianbook, 2017)。从废纸的进口状况来看，我国废纸主要的供应方为美国、英国、和日本等地，其中美国为最大供应方，占总量高于四成(CHYXX, 2018)。然而，2017 年 8 月 10 日，国家环保部、发展改革委、海关总署等部门联合修订了《进口废物管理目录》，将未经分拣的废纸列入《禁止进口固体废物目录》，导致进口废纸的市场供应收紧。这就迫使我国加快开发国内废纸回收利用的潜能，以平衡日益增长的需求。

总体来看，纸制品包装行业发展的前景可期，主要表现在以下几个方面：一是纸质包装应用广泛，世界纸质包装制品工业产值占到所有包装的三成以上，而我国的纸和纸板消费量只有发达国家的十分之一，可见在我国纸质包装产业发展空间巨大；二是纸质包装产品性能设计和装潢设计得到全行业高度重视，各种新工艺、新技术，如瓦线技术、纸箱预印技术、瓦楞纸数字印刷技术不断刷新，为纸包装产业带来更多选择；三是政策导向利好大规模纸企，行业并购频发，有利于产业格局进一步优化。四是纸质包装相对成本较低、节省资源、便于回收，是可持续的“绿色包装”，相对于其他包装品类更具发展前景(Zhang, 2017)。

1.3 电子商务消费领域纸制品包装产业链及利益相关方现状

从纸制包装的全生命周期看，要经历从开始的原材料制作纸浆，到最后的回收废纸制成再生纸的循环过程。整个产业链条可以大致划分为三个主要阶段：纸制包装的生产与加工、电子商务中的流转、以及废纸的回收与再利用(图 1.3-1)：

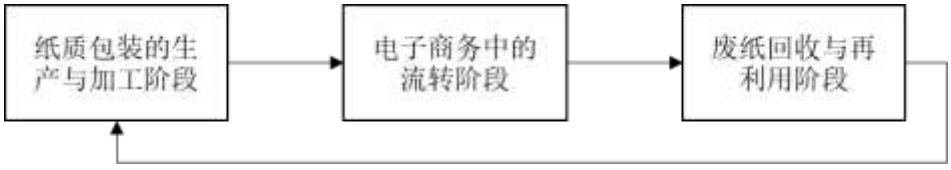


图 1.3-1：纸制包装的主要流转环节与动向

1.3.1 纸制包装的生产与加工阶段

纸制包装的生产加工产业链条相对较短，主要包括纸浆制造业、造纸业、和纸制品制造业(Chinabaogao, 2018)，如图 1.3.1-1 所示。国内造纸企业类型多样，如山鹰纸业、太阳纸业、晨鸣纸业等拥有相对完整产业链条，而景兴纸业和合兴包装等公司则仅仅主营纸制品制造。在纸制品生产加工的主产业链条之外，还有众多其他相关产业的交叉，例如用于纸浆制造和造纸的添加剂生产商、用于全产业链的生产设备提供商、与纸制品制造提供服务的设计和印刷行业、处理造纸产生三废污染的环保产业、以及纸制品出口的贸易商。下文将只针对纸制包装的主产业链条现状进行分别介绍。

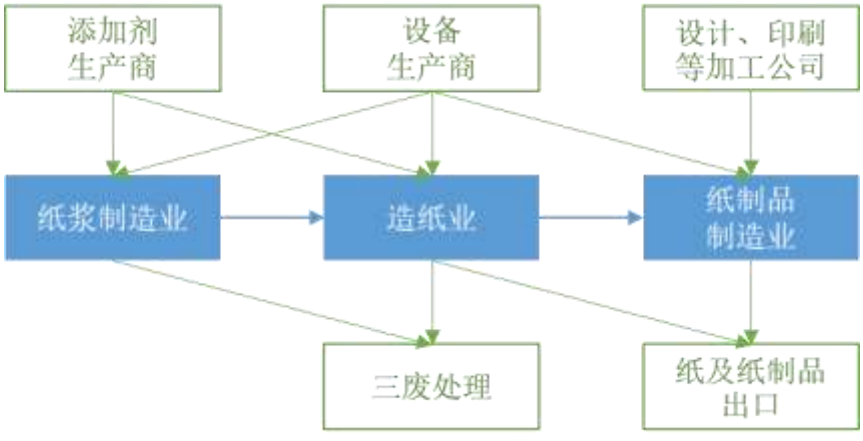


图 1.3.1-1：纸质包装的生产加工产业链条

纸浆制造业

在纸浆制造业，生产的纸浆可以分为三个主要类别，木浆，废纸浆、和非木浆(包含苇浆、竹浆、稻麦草浆、等其他浆)。其中，木浆主要用作加工包装纸中的白卡纸，而瓦楞纸、箱板纸、和白板纸的加工原料主要是废纸浆。我国每年消耗的纸浆来源于本国纸浆生产，以及进口木浆和进口废纸造浆。根据《中国造纸工业 2017 年度报告》显示，从生产情况来看，2017 年我国纸浆产量 1.03 亿吨，其中，国内木浆生产 1050 万吨，废纸浆生产 6302 万吨，进口废纸制浆 2373 万吨；从消耗情况来看，2017 年我国纸浆消耗 1.01 亿吨，国产木浆消耗 1040 万吨，废制浆消耗 6302 万吨，进口废纸制浆 2112 万吨 (China Paper Association, 2018)。我国每年的纸浆出口量较少，不足年产量的千分之一。

目前，中国对洋垃圾(外废)进口的政策正在趋严。从历史情况来看，我国国内废纸使用比例占废纸使用总量的 2/3，进口废纸使用比例占 1/3(其中美废的使用比例又占进口总量的一半)(Shi and Ma, 2018)。然而从 2017 年开始，我国陆续推出了关于限制废纸进口的政策。见下表(Shi and Ma, 2018)：

表 1.3.1-1：我国关于限制废纸进口政策一览

时间	政策	部门	相关内容
2017.04	《关于禁止洋垃圾入境推进固体废物进口管理制度改革实施方案》	国务院办公厅	调整进口废物管理目录，禁止进口来自生活源的废塑料、未经分拣的废纸以及废纺织原料、钒渣等固体废物，2017年年底开始正式实施
2017.07			中国正式向世界贸易组织(WTO)发出通知，表示将于2017年底开始不再接收废弃塑胶、纸类、废弃炉渣、纺织品等洋垃圾。
2017.08	《进口废物管理目录(2017)》	环境保护部、商务部、发展改革委、海关总署、质检总局	将未经分拣的废纸(1个品种)、废纺织原料(11个品种)等4类24种固体废物，从《限制进口类可用作原料的固体废物目录》调整列入《禁止进口固体废物目录》
2017.12	《进口废纸环境保护管理规定》	环保部	明确要求进口废纸加工利用企业规模不小于5万吨/年；对进口废纸加工利用企业环境保护管理相关的加工利用场所、设备、污染防治设施和措施等提出了明确要求；
2017.12	《进口可用作原料的固体废物环境保护控制标准》	环保部	废纸含杂率由1.5%降低到0.5%，3月1日起实施。
2018.05	《海关总署关于对进口美国废物原料实施风险预警监管措施的通知》	海关总署	1)对来自美国的废物原料实施100%开箱及掏箱检验检疫；2)自5月4日起，对中国检验认证集团北美有限公司实施A类风险预警措施，时间为一个月，期间

	该公司不再承担进口废物原料装运前检验工作；3）加强单证审核。

相关限制政策的出台一定程度上限制了原材料的供应，对国内造纸行业产生一定冲击。一方面，原材料的供给不足加上环保政策的趋严，国内成品纸的价格也随之水涨船高，进口成品纸数量也随之上涨。进口成纸的价格就作为价格顶，限制了国内成品纸价格的波动。另一方面，根据 Zheng et al. 的研究测算，若 2018 年比 2017 年废纸进口量下降 10%，则需要国内包装纸回收率提升为 80%，若下降 20%，国内回收率需提升为 83%，趋近废纸的回收极限(Zheng et al., 2018)。这对国内废纸回收加工行业，提出了相当高的要求，也同样带来了机遇。最后，废纸进口的收紧配合供给侧改革的相关政策，极大地利好于部分造纸业龙头企业。落后产能的关停、进口配额向大企业的集中、海外并购获取原材料资源，种种趋势进一步提升了的产业集中度，优化了产业格局。

造纸业

在供给侧改革的驱动下，国内造纸行业去产能效果明显，供需格局进一步改善，造纸企业呈现马太效应。在前期粗放型的发展方式下，造纸行业中的中小企业数量占比较大，由于行业驱动加上技术水平和生产方式的不规范，造成了供过于求、污染严重等问题。2011 年，工信部和林业局联合发布《造纸工业发展“十二五”规划》，开始推行造纸行业供给侧改革。根据光大证券的研究显示，“十二五”期间，行业共淘汰落后产能 3872 万吨，这一数量占 2016 年全年产量的三成，而在“十三五”期间，还将继续淘汰 800 万吨落后产能(Li, 2018)。Li(2018)的研究同样显示，造纸行业的固定资产投资同比在近年来逐渐递减。在产能出清和新增投资放缓的双重作用下，造纸产业出现明显收缩，行业格局逐步完善。

环保制度的提标完善，是一把淘汰落后产能的利剑，为造纸行业的稳定发展奠定了基础。相关环保制度措施详见下表(表 1.3.1-2)：

表 1.3.1-2：我国关于造纸环节环保制度一览

时间	政策	部门	相关内容
2016 以来	环保督查	环保部、中纪委、中组部	全国各省市建立并实施环保督察机制，对包括造纸、印刷、包装等行业的生产进行环保督查。
2016.12	《环境保护税法》	环保部、财政部、国家税务总局	2018 年1 月1 日起，以环境保护税代替排污费，针对废水废气污染物征收当量税额。
2017.01	《排污许可证管理暂行规定》	环保部	国家统一进行全国排污许可管理，采取“总量控制制度”控制年污染物排放值。
2017.01	《关于开展火电、造纸行业和京津冀试点城市高架源排污许可管理工作的通知》	环保部	2017年7月1日起，造纸企业应持证排污，建立自行监测、信息公开、记录台账及定期报告制度。
2018.03	《燃煤自备电厂规范建设和运行专项治理方案》	发改委	严格控制新建燃煤自备电厂、全面清理违法违规燃煤自备电厂、严格依规限期完成环保改造、坚决淘汰燃煤自备电厂落后产能等。

从环境督查配合环保提标，到排污许可制度的趋严，再到造纸行业能源侧的改造……多重因素的叠加使技术革新能力和风险控制能力不足的中小企业成本压力增大，落后产能进一步出清，而经营优势进一步流向行业龙头企业。据统计，2017 年超过三成的箱板纸产量集中在山鹰纸业、景兴纸业、太阳纸业、理文造纸四家企业，1/5 的瓦楞原纸产量来源于玖龙纸业、金凤凰纸业、荣成纸业、联盛纸业，而亚洲浆纸业、万国太阳、广西金桂、湛江晨鸣四家公司贡献了近六成白卡纸产能(Li, 2018)。除政策为龙头纸企带来的经营优势外，企业本身的发展战略同样进一步提升了竞争优势。一方面，根据东方财富 Choice 金融终端数据整理，与 30 家上市造纸企业相关的并购或被并购事件从 2017 年 1 月 1 日至今共 92 起，反映了快速的产业融合；另一方面，国内许多造纸企业向海外扩张，例如发掘东南亚等地森林资源丰饶、劳动力廉价的优势，迅速完成产业战略布局(Zheng et al., 2018)。由此可见，整个造纸行业的变革不仅没有限制行业龙头企业，反而为他们的长久发展扫清了障碍。

纸制品制造业

从整个包装产业的类别来看，包装的种类包含竹木包装、金属包装、纸质包装、塑料包装、玻璃包装、等其他品类。其中，纸质包装凭借其在节约能耗、节省资源、环境友好等方面的优越性，被公认为绿色包装产品，近年来也受到越来越多的青睐。根据中国产业信息网的统计显示，全球纸质包装市场规模占到所有包装类别的近四成左右(CHYXX, 2017)，是几大包装种类中市场份额最大的。根据预测，全球纸质包装市场规模在 2018 年将超过 3300 亿美元，但增速将逐年放缓至 4.0%以下(ASKCI, 2017)。中国的包装市场发展迅速，已经成为仅次于美国的第二包装大国。其中纸制品市场增长稳定，预计在未来几年能保持 5-6%的增速，将到 2020 年左右成为最大产量国(CHYXX， 2017)。然而，在宏观的增长趋势下，国内纸质包装行业格局正发生着潜移默化的变化，这主要反映在以下方面。

从供应方来看，我国的政策因素在短期内产生的影响背离了经济规律。一方面，外废的进口限制以及国产原料的供应不足，极大地提高了造纸的原料成本，原料成本向下游传导；另一方面，由于纸质包装印刷行业准入门槛较低，我国中小规模企业占全国包装企业数量九成以上，而受环保政策影响，市场份额逐渐流向规模以上企业。上游原料的价格上涨因素叠加行业内企业数量萎缩因素，导致了纸制包装产品的价格有一个飞速的上涨(见图 1.3.1-2)。根据卓创资讯的统计数据显示，箱板纸和瓦楞纸的价格均在 2017 年下半年达到最近十年的峰值(Li, 2018)。然而，价格的疯涨却没有导致大规模减产。

从需求方看，下游产业的增长拉动纸质包装制造业，并覆盖了政策因素导致的产业萎缩。包装纸的下游行业主要包括物流、日化用品、食品饮料、家电、和电子消费等。在电子商务蓬勃发展的刺激下，各下游行业在近几年均保持了相对稳定的增长，

其中物流行业则是保持了超过 50%平均年增长率 (见表 1.3.1-3) (Li, 2018)。纸制包装的成本顺利的向下游逐级传导。

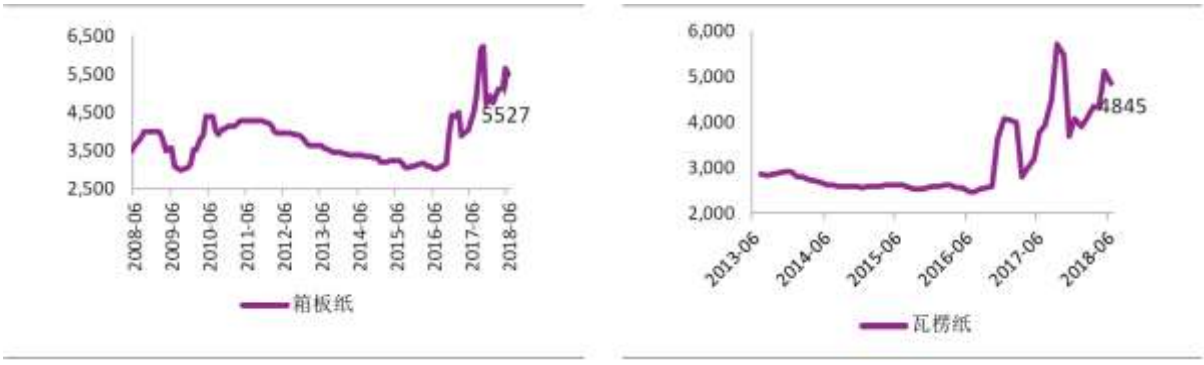


图 1.3.1-2：箱板纸平均市场价(元/吨)与瓦楞纸平均市场价(元/吨)

表 1.3.1-3：2012 – 2016 年纸质包装下游行业增长量

增长率	物流	日化用品	食品饮料	家电	消费电子	医药
2012	54.79%	21.57%	13.73%	-1.50%	4.72%	9.79%
2013	61.58%	18.77%	12.78%	18.87%	22.29%	0.22%
2014	51.96%	11.23%	5.30%	11.74%	12.99%	14.95%
2015	48.07%	10.89%	3.21%	6.01%	0.64%	-2.27%
2016	51.33%	11.58%	5.12%	6.23%	19.26%	5.63%
复合增长率	40.63%	10.32%	3.78%	8.38%	10.64%	3.53%

由此可见，相关政策的叠加干预并没有深度的影响供需平衡，而产业集中度的提升，技术的革新，以及行业的格局优化保障了我国纸制包装行业的稳定发展。

1.3.2 电子商务的流转阶段

从纸制包装的流转阶段来看，大致由包装产品出厂，经由分销渠道，到达消费者(包含末端和非末端用户)两个环节(图 1.3.2-1)。传统的分销渠道包含了批发商、代理商、零售商、贸易公司等，而新的分销渠道则是创新的网络技术和电子商务平台赋予了传统渠道更快速、便捷的通道，更高效的链接了生产者与消费者。电子商务作为新兴的分销工具之一，根据消费者的不同性质，其种类也多种多样(包含 B2B、B2C、M2C、

O2O 等)。而在纸制品包装的流转过程中，主要用到的种类分别为 B2B 和 B2C。这里的 B2B 主要指纸制包装经由电子商务渠道到达非末端用户（大/小型企业、小型电商），例如下游产品制造业(食品饮料和日化用品等)、纸包装零售商(搬家公司或包装用品商店)、或物流公司，包装后的产品或纸制包装产品再最终流向末端用户(个人消费者)；而 B2C 指的是末端用户直接经由分销渠道获得纸制包装的过程。这里的末端用户指的是纸制包装在回收或丢弃之前的个人消费者，而非末端用户指在流转中到达末端用户之前其他环节的消费者。

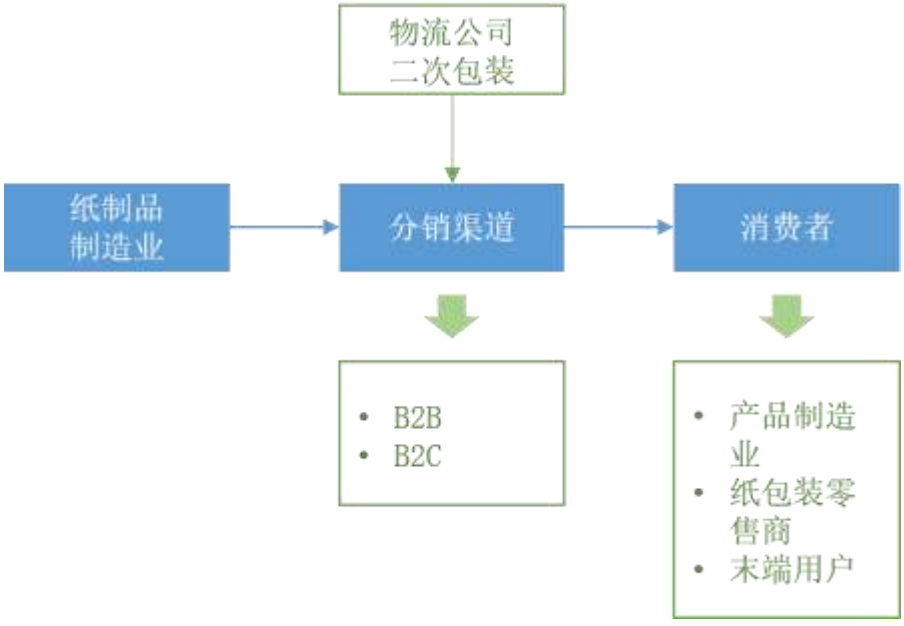


图 1.3.2-1：纸质包装电子商务流转阶段的产业链条

分销渠道

目前，中国共有将近 1500 家 B2B 电商企业。中国近几年 B2B 电子商务的飞速发展受益于几大因素。首先，我国 2017 年 GDP(国民生产总值)增长 6.7%，稳定在合理区间，近年来 CPI(居民消费价格指数)走势平稳，而 PPI(生产者价格指数)迅速提升(国家统计局)，国内经济的回暖为电子商务发展奠定了坚实基础。其次，企业信息化的普及为电子商务 B2B 的推进铺平了道路，中国的中小企业互联网和计算机使用率均已超

过 95%，虽然在线交易的占比不算太高，但未来企业互联网转型的空间巨大(YIGUAN，2017)。最后，大数据、云计算、支付系统、物联网、移动终端等方面的技术革新极大的拓展了 B2B 电商的商务渠道，提升了运营效率，并在交易中提供了良好便捷的服务。根据电子商务研究中心的统计数据显示，2017 年我国的 B2B 电商市场交易规模达到 20.5 万亿人民币，同比增长 22.8%；而 B2B 电商市场的营业收入规模达到 350 亿元，同比增长 34.6%(zhang, 2018)。

围绕 B2B 的发展，中国同时形成了完整稳定电子商务生态圈，除了采购方和供应方，还有在线支付服务(银联、支付宝等)、物流服务(顺丰、云鸟等)、认证服务(中国电子商务认证中心和中国信息安全认证中心)、媒体推广(百度、托比网等)、和其他衍生服务(数据与咨询、营销与培训等)，而 B2B 电商服务平台也分综合电商平台(阿里巴巴、马可波罗等)和细分行业垂直电商平台(棉庄网、找钢网等)。

在 B2C 领域，如前文所述，2017 年我国网络零售行业交易金额达到将近 7.2 万亿元，同比增长了 32.2%(CNNIC, 2018)。虽然年增速已经逐渐放缓至 30%左右(如图 1.1.1-2 所示)，但依然保持了较高的增长速度，标志着国内的 B2C 领域已经逐渐跨入成熟发展时期。易观(2017)对 B2C 电子商务产业进行了外部宏观环境分析(PEST 分析)，分析表明，从政治环境、社会环境、经济环境、和技术环境综合情况来看，中国市场仍然利好于 B2C 领域的发展(Analysys，2017)。也有分析称，国内已经处于电商流量的后红利时代，但海外 B2C 的电商市场增长潜力已经开始逐渐释放(CHYXX，2017)。

中国零售市场 B2C 的市场模式主要分为三个类别：一种是零售商建立网络平台，对其经营的产品进行统一采购、展示、交易、并配送到最终消费群体的行为，例如京东和唯品会；也有为零售商提供线上交易平台，并提供交易支持的企业类型，例如天猫和淘宝；还有由生产厂商自建的网络平台，用于销售自有产品，例如乐视商城和小米商城(Analysys，2017)。与 B2B 电子商务类似，在 B2C 领域中同样形成了电子商务

服务生态圈，实现了由网络零售平台为中心，制造商、经销商、物流、在线支付、技术支持、代运营、购物咨询等多领域相互交错的新型产业态势。不仅如此，新兴的“网红经济”等元素同样为该产业注入新鲜血液。

总的来说，中国电子商务(B2B 和 B2C)领域已经进入深度成熟发展阶段，从最初的综合网络平台建设，再到垂直电商兴起，再到现在的相关细分行业融合，完整的电子商务生态系统已经搭建完成，既能满足日益增长的国内市场的需求，又对全球电子商务的发展起到了极大的推动作用。当然，产业的健康发展离不开政策法规的支持和约束，比如本文探讨的过度纸质包装问题，就需要政府相关部门、行业企业、与消费者共同探寻一个更加“绿色”的可持续发展方案。

快递物流

近七年，国内网络零售额不断增长(图 1.3.2-2)，仅 2017 年，中国快递业务量累计高达 400.6 亿件，比 2016 年增长 28%，在世界份额占比大于 40%，连续 4 年蝉联世界第一。快递业务比 2016 年增加 87.8 亿件，对世界快递业务增长量的贡献率超过 50%。其中，同城（在地）业务量共 92.7 亿件，同比增长 25%；而相对的异地业务量共 299.6 亿件，同比增长率为 28.9%；国际/港澳台快递业务量累计共 8.3 亿件，同比增长 33.8%。异地业务量的大幅增长势必导致碳排放量的显著提高(国家邮政局，2017)。2011-2017 年全国快递业务的增长速度有不可遏制的趋势，发展异常迅猛。(见图 1.3.2-2)

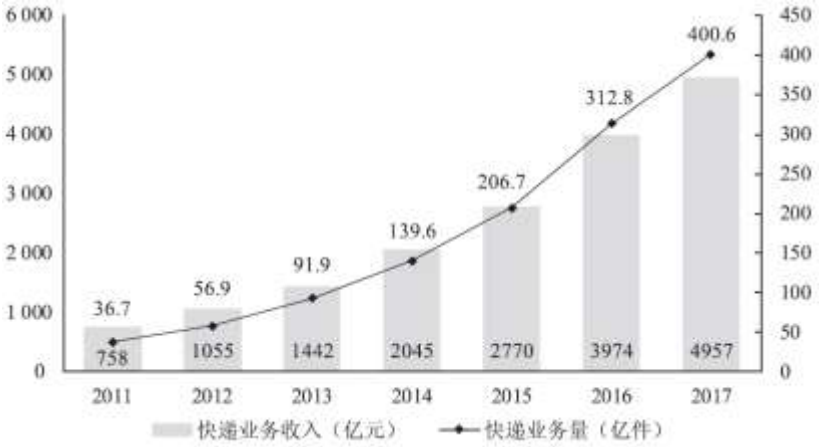


图 1.3.2-2：2011-2017 年全国快递业务发展情况

国家邮电局提供的牛皮纸板包装箱大小共有十二个规格，并对所包装的物品做出相应的指导建议(如表 1.3.2-1 所示，表 1.3.2-2、表 1.3.2-3 分别为邮政、顺丰和德邦快递提供的纸箱规格，仅作为参考)。固定规格的纸箱在很大程度上节约了运输空间、减少了物品在运输中的晃动或碰撞，既有效的节省了运输成本，又降低了因物品损坏导致的客户投诉。而事实上，尤其是在电子商务领域，客户满意度尤其被商家重视。商家除了选择合适尺寸的包装纸箱，为了避免商品在运输过程的损坏，还需要一定量的填充材料包裹在商品四周作为缓冲。而使用过大的包装和过多的填充材料与运输行业中的“野蛮装卸”乱象不无关系，尽管很多状况下商品(如毛巾、筷子等日用品)本身并不容易损坏。另外，仓储问题也被一些消费者识别为易造成过度包装的原因之一。当消费者从线上同一商家或不同商家购买多件商品时，商品本身由于可能存放于城市的不同仓库，或不同城市，一次线上交易可能产生多个包装和多线运输，而交易的本身的商品总量却可能只占很小的体积。由于包装材料的成本往往直接传导给最终用户，因此物流行业在一定情况可能下加重了过度包装问题，这与节约运输空间、减少运输成本的设计初衷是不相符的。

表 1.3.2-1：标准邮政纸箱规格及主要包装内容物

编号	长(mm)×宽(mm)×高(mm)	主要包装内容物
1	530×290×370	大家电等
2	530×230×290	大小家电等
3	430×210×270	杂物、大号旅行包、厚衣服等

4	350×190×230	靴子、中等大小包、抱枕等
5	290×170×190	鞋子、小件衣服、杂志、书籍等
6	260×150×180	零食、奶粉、面膜等
7	230×130×160	化妆品、杯子、保温被、胶带等
8	210×110×140	润肤水、面膜、CD 等
9	195×105×135	抽纸、洗面奶、面膜等
10	175×95×115	文具用品、纸巾、毛巾、湿巾等
11	145×85×105	香水、香皂、手机等
12	130×80×90	鼠标、面霜、化妆品、一些小的饰品等

表 1.3.2-2：顺丰快递包装 6 款标准纸箱

编号	长(mm)×宽(mm)×高(mm)	最大承重量
1	200×180×100	1.5 kg
2	250×200×180	3 kg
3	300×250×200	5 kg
4	360×300×250	10 kg
5	530×320×230	15 kg
6	700×400×320	15 kg

表 1.3.2-3：德邦快递纸箱包装规格及收费标准

编号	长(mm)×宽(mm)×高(mm)	价格
1 号	600×500×400	15 元/个
2 号	500×320×540	10 元/个
3 号	460×280×330	7 元/个
4 号	300×230×230	5 元/个
快递小盒	200×180×100	1 元/个
快递 1 号	250×200×180	2 元/个
快递 2 号	300×250×200	3 元/个
快递 3 号	360×300×250	4 元/个
快递 4 号	530×320×230	5 元/个

2016 年，全国快递行业包装箱消费总量约 86 亿个，其中由于快递运输环节直接使用的纸箱数量占比 43%，约为 37 亿个。剩余 57%为网购卖家或电商平台的商品自带的包装。这其中不乏快递物流行业在产品已有包装的情况下进行二次包装， 然而值得欣慰的是，对比 2015 年的数据，尽管 2016 年全国快递业务量增长了约 100 亿件，快递业包装箱的整体使用量反而出现了负增长，同比降低约 13.32%(中国邮政快递报，2017)。说明持续推进的快递包装业规范治理和绿色包装政策已经取得了显著效果。

消费者

随着零售业经历了从传统模式向线上模式的转型，再发展至现今线上消费与线下体验相结合的新模式，消费者行为习惯也随之变化。根据麦肯锡对超过 5900 名中国消费者的采访分析，在消费行为偏好方面，线上线下相融合的全渠道购物成为主流消费方式，93%的受访者购买电子产品时会先在线上研究再去实体店体验；社交媒体的发展促进了电商与消费者之间的互动，麦肯锡研究显示，社交媒体增加了用户 10%的购物时间(Wang et al., 2017)。电商的发展虽然在一定程度上促进了消费者购物行为习惯的改变，但从消费者的利益角度出发，网购仍然存在着诸多问题，其中就包括物流行业“野蛮装卸”导致的商品损坏问题。

据电子商务研究中心统计，2017 年零售电商类投诉占电商全行业投诉的 60.59%，比例最高，投诉占比同比增长 7.91%。投诉热点问题包括发货问题、商品质量、疑似售假、物流问题等等。而物流企业被投诉占比前 10 名为：海带宝 22.50%、转运四方 15.63%、快鸟转运 7.50%、天天快递 6.88%、百世快递 6.88%、天马迅达 4.38%、申通快递 4.38%、顺丰速运 3.75%、韵达速递 3.14%、百通物流 3.13%。投诉问题主要包括丢件破损难获赔偿、转运速度慢、收费乱、客户服务差等(CIECC, 2018)。中国消费者协会对国内 10 家较大快递公司体验调查报告显示，46.8%的快递件在原有包装的基础上又进行了第二次包装，7.9%的收件外包装发生破损，16.1%的包装内物品发生损伤(China Consumers Association,2017)。在对快递网点的调查中，近半网点存在“暴力”分拣情况：尽管大部分网点人员在搬运货物时比较注意避免猛拉猛拽货品(78.6%)，避免脚踩或者坐卧快递件(91.7%)，也大多能够对具有易碎标志的物品谨慎对待(76.6%)，但对物品抛扔脚踢(50.0%)和从高处直接将货品扔到地面上(38.0%)的现象仍较多存在(China Consumers Association,2017)。由此看来，无论是从消费者、线上零售商、还是物流公司的利益角度来看，通过过度包装以保证货物的安全完整性，似乎成为合理解决争端及投诉的有效手段。然而，这对下游纸制品的回收再利用环节提高了相当大的难度。

1.3.3　废纸回收与再利用阶段

我国的包装废弃物的去向可大致分为两种情况，一种是经由回收商回收，进入下一级应用，例如制造纸浆、制造家具板材、制作土壤改良剂等；另一种则是作为固废，进入固废处理系统(图 1.3.3-1)。

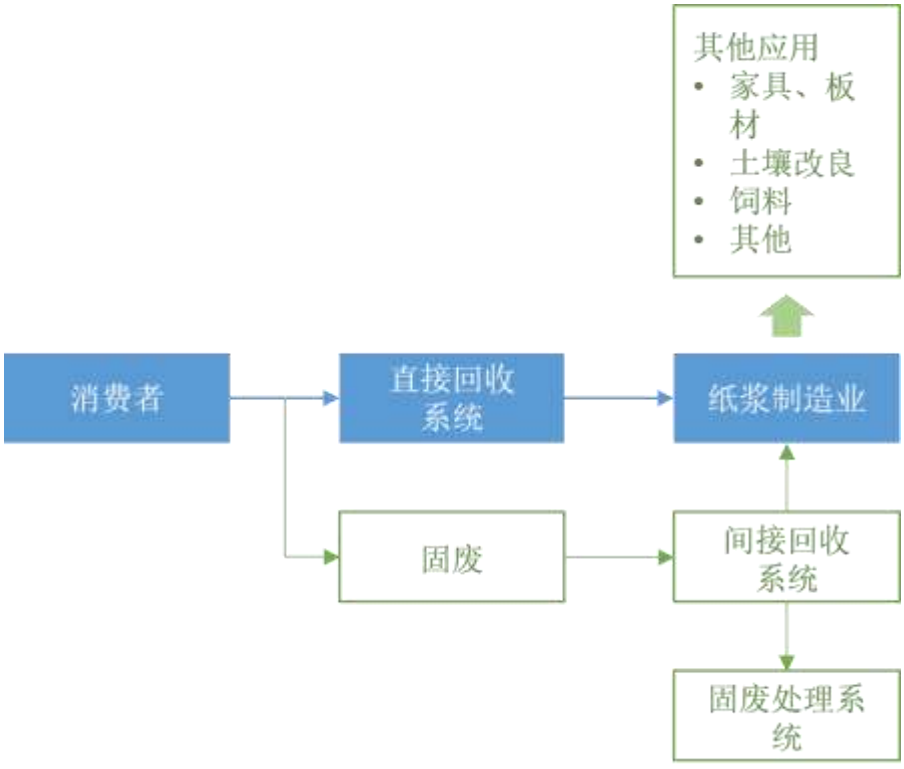


图 1.3.3-1：纸质包装回收再利用阶段产业链

Zhou et al. (2010)研究了我国包装废物回收情况，将纸包装废弃物的流向归纳为四种情况：一是少部分低回收价值的小包装纸混入城市生活垃圾中；二是部分流入不具备回收条件的落后地区；三是部分居民消费后产生可回收废弃物直接给卖给回收商；四是很大部分从生产商和流通领域在消费后通过回收市场或公司进行回收(图 1.3.3-2)。

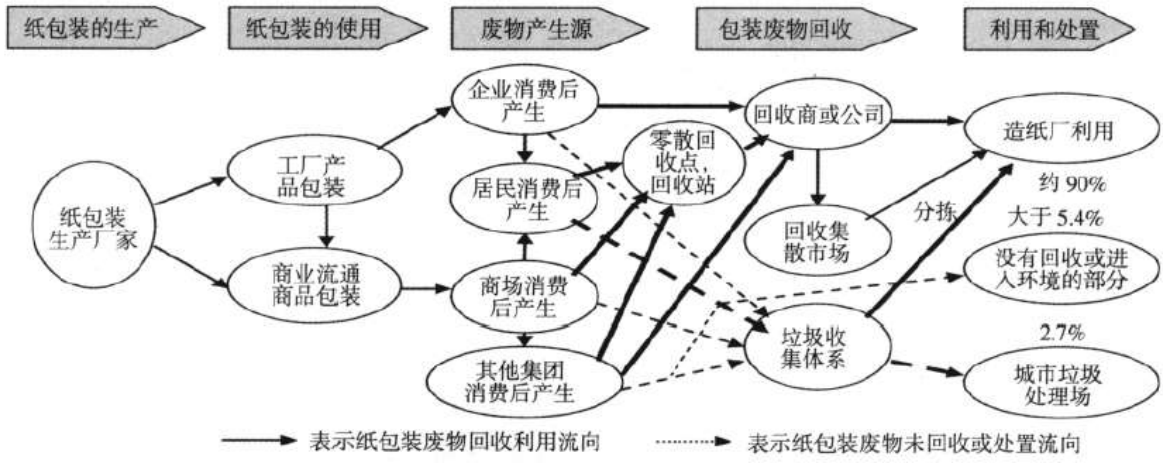


图 1.3.3-2：纸质包装废物的产生与流向

从目前回收情况看，我国城镇居民家中废旧的报纸、书本和其他商品包装物用完后一般会交售到附近的废品回收处。除偏远的落后地区外，从城市各社区街道到大小乡镇都有个体废旧物资回收网点，超市、超市等也不再将废弃包装当成普通垃圾，一般都通过招标回收商贩，统一交售到分拣打包站。中国县级以上城市基本上不会出现随意丢弃大量废纸或纸质包装物的现象(即使偶有发生，纸制品也会被拾荒者拾走卖钱)，尤其是垃圾桶中或街面上很少会有废弃纸制品。

从清运情况来看，我国废纸回收由原来的散装运输，开始尝试统一打包物流运输体系。首先引进打包机试点，逐步自行设计和生产打包机。我国废纸打包机目前的生产和利用水平已基本和国际水平接轨。在打包站使用打包机对回收废纸进一步分拣、打包。由此增大了废纸的运输半径，从而增加了造纸厂收购量，增强了其对废纸质量的控制，也显著地改善了回收废纸的质量。同时，分拣打包好的废纸由物流公司单独运送或由造纸厂送货后的空车带回厂区，废纸运输半径大幅增加，运输速度更加快捷(Zhang and Liu，2012)。

我国废纸回收率平稳增长，但仍低于世界平均水平。2014 年，我国废纸回收率达到最高值 48.1%，而 2004 年仅为 30.4%(图 1.3.3-3) (Chinabaogao，2017), 2016 年回收率为 47.6%, 较 2015 年提高了 0.9%(Guo，2017)。2017 年美国纸质消费品中有 65.8%

被回收利用，与 2016 年最高纪录值 67.2% 相比，废纸回收率稍有降低(Chen, 2018)。而欧洲的废纸回收率在 2015 年就高达 71.5%，高于第三届欧洲废纸回收计划中废纸回收委员会所设定的目标（70%）(Wu，2016)。2014 年全球废纸回收率最高的国家是韩国，达到了 88%，在世界十大主要造纸国家中名列前茅(图 1.3.3-4)(Chinabaogao，2017) 。

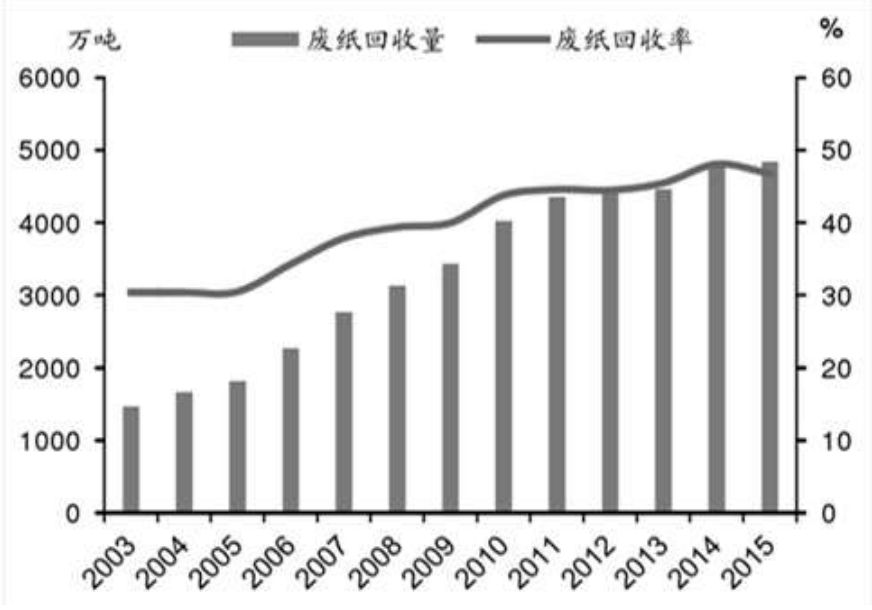


图 1.3.3-3：中国废纸回收量及回收率

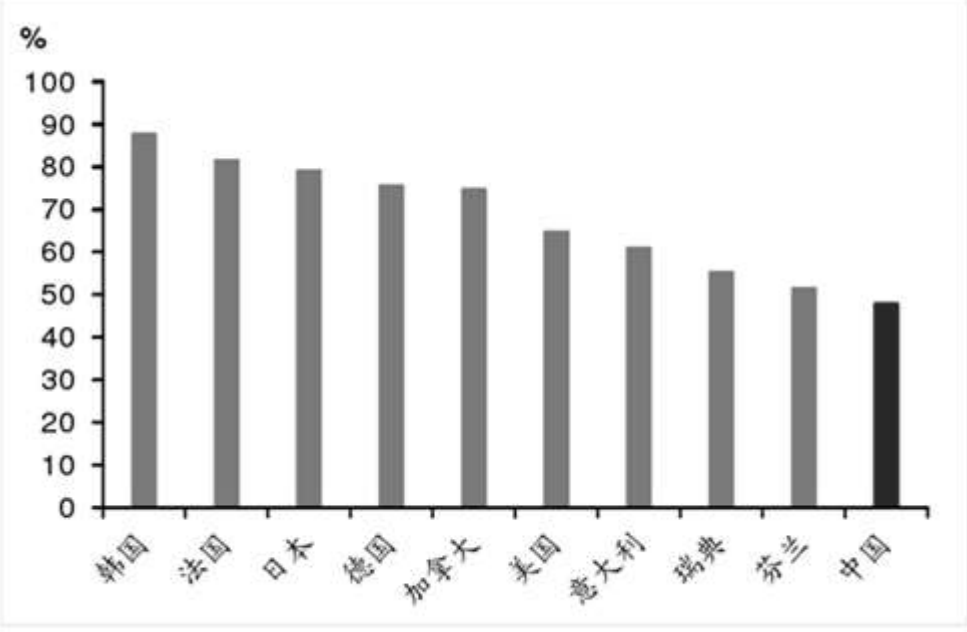


图 1.3.3-4：2014 年全球十大主要造纸国家废纸回收率

从再利用的情况来看，废纸的回收价值较高。废纸的纤维结构与天然植物纤维相似，密度小，具有较高的弹性模量，价格低廉， 而它的可再生性和生物降解性是最突出的优点。废纸纤维与植物纤维的差异是: 废纸的纤维细胞壁在抄纸时发生了不可逆的物理变化，即角质化。因此废纸纤维的可塑性和润胀能力降低，脆性增加。其主要应用如下：

- 废纸适合用于制备复合材料，其优势为不需要作为造纸原料时的预处理过程，包括脱墨、洗涤、精制等。复合材料主要包括：废纸/生物降解树脂材料、废纸/热塑性聚合物材料、废纸/水泥基复合材料等；
- 废纸经过特殊的改性处理后，具有不同的物理化学特征，可以以粉状、片状、膜状、纤维或溶液等不同形态出现，因此用废纸回收再造的功能材料极具灵活性和广泛应用性。目前研究较多的材料包括吸附、保温和耐火功能的材料等；
- 此外，废纸还可再生成包材中的缓冲物、纸浆模塑材料等(Zhang et al.，2008)。

我国废纸利用率在 2013 年达到历史最好水平 73.4%，而 2004 年仅为 58.2%， 但 2016 年又降低至 72.0%，同比年下降率为 0.6%。目前，我国纸制品再利用率已经与世界较高水平相当(Guo，2017)。欧洲 2013 年的废纸再利用率为 71.7% (ERPC， 2013) 。其废纸再利用总量稳定增长，而纸的消费量则维持在 5700 多万吨，呈减少趋势，该项消费量在 1998 年刚开始统计时仅为 1800 万吨。在日本，2008 年造纸行业的生产原浆仅占 38.8%；当年的废纸回收率就高达 75.1%，相应的利用率为 61.8%，两项水平均领先世界 (Ding，2010)。

工信部、商务部、和科技部关于加快推进再生资源产业发展的指导意见指出，未来应加快推进废纸分拣加工中心规范建设，在重点区域建立大型废纸仓储物流交易中心，有效降低废纸区域间流动成本。提升废纸分拣加工自动化水平和标准化程度，推广废纸自动分选技术和装备，提高废纸回收利用率和高值化利用水平。推动废纸利用

过程中的废弃物资源化利用和无害化处置，降低废纸加工利用过程中的环境影响。到2020年，国内废纸回收利用规模达到5500万吨，国内废纸回收利用率达到50%。

在电子商务领域纸制品包装的产业链全景图及各利益相关方如下所示(图 1.3.3-5)，这也在一定程度上反映出了包装纸在电子商务领域的全生命周期。包装纸经过了从原料供给、生产加工、设计印刷、商家采购、物流配送，最终到达消费者，再经下游分拣回收，最终又回归加工为纸浆原料的漫长过程。在这个过程中，众多环节对我们的自然环境造成了的破坏，对气候产生了影响，甚至对人类的健康产生威胁。下一部分本报告将围绕环境影响问题，以纸制品包装的生命周期为轴线，开展相关问题的文献学习。

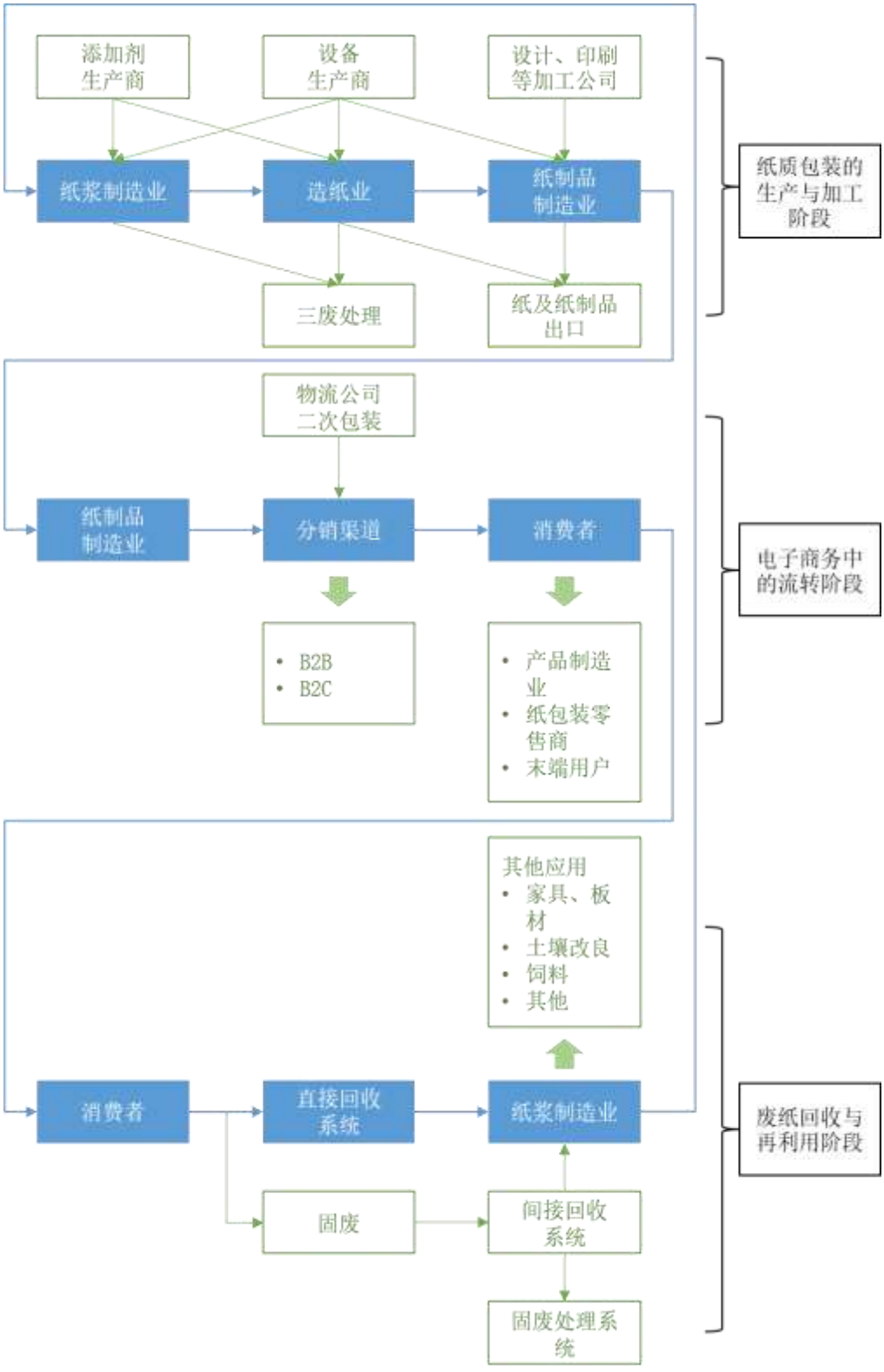


图 1.3.3-5：纸质包装产业链全景图及利益相关方

2. 认知 - 纸制品包装对环境的影响

这一部分将阐释纸制品包装对环境的潜在影响，重点展示了在生产加工阶段和回收利用阶段的环境影响。根据国际标准化组织在 IS014040 中制定了生命周期评价(LCA)环境评价方法的技术框架：即是 1)确定 LCA 的目标、全生命周期的范围、及边界；2)清单分析，确定每一流程的输入(原料、辅料、能源等)和输出(水、气、固污染)，形成全生命周期清单表；3)对清单数据进行定量的影响评价；4)结果解释 (Li et al., 2006)。Liu et al.(2008) 在对瓦楞纸箱的全生命周期分析中，确定了由原料的生产与加工、产品的生产加工、运销过程、使用和维护、废弃与再利用五个过程组成的全生命周期范围(图 2-1)。并指出，由于一般认为纸箱使用一次即废弃，且不需要维护，在这个过程中并无明显物耗和能耗，因此对环境几乎没有影响，从而主观的略去了对使用和维护这个流程的环境影响分析(Liu, Yang and Han， 2008)。这与前文描述的纸制包装产业链条相符，即：纸制包装的生产与加工(包含原料生产和产品生产)、电子商务中的流转(运销过程)、以及废纸的回收与再利用(废弃与再利用)。其中，在电子商务流转过程，物流的主体为商品及货物，包装材料仅为载体，对环境并不产生直接污染，且相对于货物来讲，纸制包装在运销过程中产生的能耗可以忽略不计。

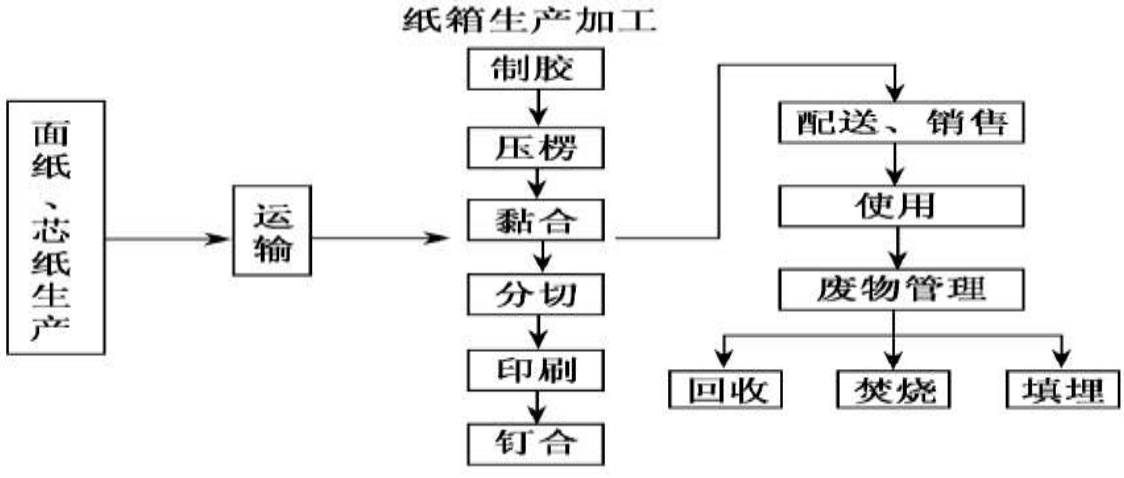


图 2-1：纸箱生产加工全生命周期

2.1 纸制包装生产过程的环境影响

2.1.1 消耗情况

从纸制包装的生产过程中的消耗情况来看，可以主要分为原料消耗和能源消耗。原料消耗包括原纸生产需要的废纸和制浆造纸过程中的添加剂等；而能源消耗则包含生产过程中用到的水、煤、电等。Ren and Huo(2010)采用生命周期影响评价（LCA）末端计量方法(LIME)，根据对瓦楞纸箱企业（大连地区）的实际生产调研，采取 LCA 功能单位为生产 1 平方米 瓦楞纸箱 （由 3 层瓦楞纸板组成，图文印刷面积约占总表面积的 30%），系统边界为生产全过程，包括原纸供给到制成瓦楞纸箱产品，得出各功能单位瓦楞纸箱生产和加工过程的输入 （物耗、能耗） 数据清单(表 2.1.1-1)。在过程中，制板工序用电量超过总用电量的 50%，印刷工序的用电量则占到 30%以上；压楞、黏合和烘干过程需要的蒸汽消耗大量的煤资源 (Ren and Huo，2010)。Nian and Wang(2012)取 3 种不同规格瓦楞纸板的生产情况，分别计算了能源消耗。瓦楞纸板幅宽 1800 毫米，瓦楞纸板类型表示为：楞形-面纸定量/芯纸定量/面纸定量(g/m^2)，研究中采用的 3 种瓦楞纸板类型分别为：（1）B-140/110/170；（2）B-250/140/175；（3）CB-250/140/140/140/175。生产瓦楞纸板 100 平方米，3 种纸板的能耗物耗见表 2.1.1-2。经比较可以得出，纸板层数越多、原纸定量越大，生产能耗越大；而当纸板层数和原纸定量相同时，车速对瓦楞纸板生产的能耗影响很大，车速越慢，各生产元件热传递损失越多，能耗越大。

表 2.1.1-1：1 m^2 瓦楞纸箱生产加工过程输入数据清单(Ren and Huo，2010)

类别	名称	数量/($g \cdot m^{-2}$)
原料	原纸	488.45
	油墨	3.43
	淀粉	8.47
	NaOH	0.84
	H_2SO_4	2.52
	聚醋酸乙烯乳胶	10.00
	聚丙烯打包带	5.00
	水	831.92
能源	煤	89.56
	电/($kWh \cdot m^{-2}$)	5.39×10^{-2}

表 2.1.1-2：生产 100 m^2 瓦楞纸板的能耗物耗情况(Nian and Wang，2012)

纸箱类型	车速 /(m • min^{-1})	耗蒸汽 /kg	耗煤 /kg	耗电量 /kWh
①	150	42.53	9.11	3.82
②	140	46.36	9.87	
③	130	78.03	13.94	3.94
	60	148.75	28.45	

2.1.2 排放情况

从排放情况来看,废气、废水、和固体废弃物在纸制包装加工生产过程均会产生。Ongmongkolkul et al. (2001) 对越南某地以 15%木浆和 85%废纸浆制造纸箱的工艺进行了分析，并对制造工艺全生命周期的污染排放进行了统计(见表 2.1.2-1)。从表中可以看出，废气排放污染物种类繁多，例如碳氧化合物、碳氢化合物、含硫化合物、含氮化合物、易挥发性有机气体等，而这其中 CO_2 的排放占到整体废气排放的 96%、CH_4 占 3%，单从排放量来看，温室气体为纸箱制造过程中的主要气体污染；而水污染中，化学需氧量 COD(53%)、悬浮体 Suspended solids(32%)、和生化需氧量 BOD(13%)又占主导的地位，共占水污染物的 98%；在产生的固体废弃物中，工艺废物(Process Waste)占 74%。这个结果与 Ren and Huo(2010)对 1 m^2 瓦楞纸箱生产加工过程产生的环境影响做出的量化分析结果十分相近(如表 2.1.2-2 所示)。由此可见，在所有的污染排放中，从排放量来看，CO_2 和 CH_4 构成最主要气体污染物；化学需氧量、悬浮体和生化需氧量为主要水污染因素；而工艺过程固废又是固体污染物中最主要的组成部分。

表 2.1.2-1：越南纸箱制造工艺(15%木浆+85%废纸浆)污染物排放情况

Substances	Amount	Unit
Emission to air		
CO	1.16	g
CO2	510	g
CO2 (non-fossil)	310	g
H2S	$4.16*10^{-3}$	g
CH4	22.4	g
NH3	1.44	g

NOx	3.09	g
SOx	1.57	g
VOCs	$20.50*10^{-3}$	g
Emission to water		
AOX	$6.28*10^{-3}$	g
BOD	13.4	g
Chloride	1.15	g
COD	56.1	g
Fats and oils	$56.0*10^{-3}$	g
Nitrate	0.11	g
Phosphorus	$56.1*10^{-3}$	g
Sulfate	0.18	g
Suspended solids	33.7	g
TOC	0.12	g
Solid waste generation		
Plastics packaging	5.25	g
Process waste	58.60	g
Steel and metal scrap	15.12	g

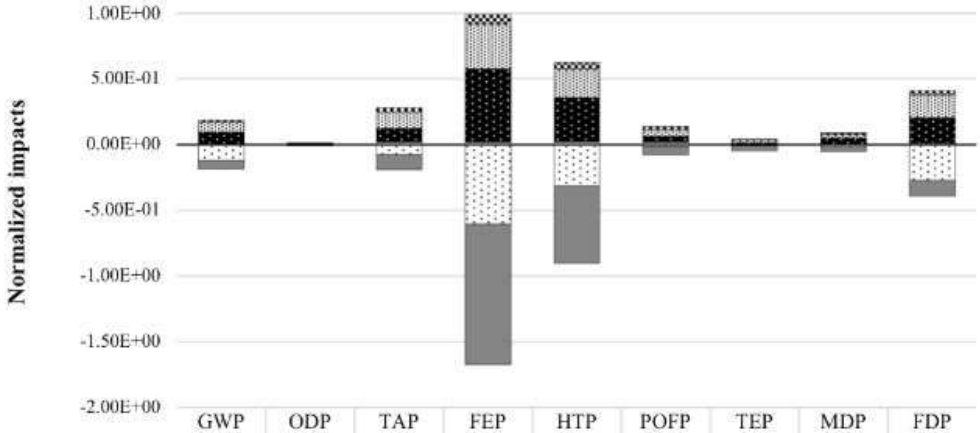
表 2.1.2-2：1 m^2 瓦楞纸箱生产加工过程环境影响量化结果

名称	制版工序	印刷工序	成箱工序
CO_2	1.39	2.91×10^{-1}	2.15×10^{-2}
CH_4	1.86×10^{-4}	4.38×10^{-4}	7.70×10^{-7}
N_2O	1.86×10^{-4}	3.45×10^{-4}	2.40×10^{-6}
SO_2	7.90×10^{-3}	1.50×10^{-3}	6.60×10^{-5}
SO_X	1.71×10^{-5}	3.85×10^{-5}	1.52×10^{-6}
烟尘颗粒	1.90×10^{-3}	4.23×10^{-4}	5.88×10^{-6}
COD	2.80×10^{-1}	2.69×10^{-2}	-
N 含量	2.60×10^{-3}	7.00×10^{-3}	-
P 含量	2.30×10^{-4}	6.16×10^{-4}	-
灰和煤渣	1.80×10^{-2}	4.70×10^{-3}	-
工业垃圾	2.01×10^{-6}	1.68×10^{-6}	-
低放射性废物	2.46×10^{-7}	1.52×10^{-7}	8.11×10^{-9}

2.1.3 环境、生态、及人类影响

纸质包装生产加工过程对自然资源和化石能源的消耗，以及大气、水、和固体污染物的排放，对生态环境以及人类的健康产生了诸多威胁。这些威胁有些是缓慢的，有些是极端的，有些是易于解决的，也有些是难以修复的。F. Corcelli et al. (2018) 以

芬兰北部的纸浆和造纸厂中的制造阶段作为模型，利用 SimaPro 8 LCA 软件进行评估，运用 ReCiPe Midpoint(H)影响评估方法，得出纸浆和纸张的生产过程产生环境影响的类别及份额，从产生的水耗的 50％到淡水富营养化的 88％。特别的是，纸浆生产过程造成了全球变暖潜势(Global Warming Potential ,GWP, in kg CO2 eq)(占总全球变暖影响的 46％)，臭氧破坏潜势(Ozone Depletion Potential, ODP, in kg CFC-11 eq)(占 39％)，淡水富营养化潜势(Freshwater Eutrophication Potential, FEP, in kg P eq)(占 55％)，人类毒性潜势(Human Toxicity Potential, HTP, in kg 1,4-DB eq)(占 46％)，金属消耗潜势(Metal Depletion Potential, MDP, in kg Fe eq)(占 42％)和化石枯竭潜势(Fossil Depletion Potential, FDP, in kg oil eq)(占 46％)等诸多生态环境与人类健康影响。此外，其他生产环节的环境影响还包括陆地酸化潜势(Terrestrial Acidification Potential, TAP, in kg 1,4-DB eq), 光化学氧形成潜势 (Photochemical Oxidation Formation Potential, POFP, in kg NMVOC), 陆地生态毒性潜势 (Terrestrial Ecotoxicity Potential, TEP, in kg 1,4-DB eq), 水资源损耗潜势 (Water Depletion Potential, WDP, in m^3)(不同生产阶段对不同环境影响的贡献见图 2.1.3-1)。



	GWP	ODP	TAP	FEP	HTP	POFP	TEP	MDP	FDP
EoL phase	-6.47E-02	-4.20E-03	-1.13E-01	-1.07E+00	-5.92E-01	-6.50E-02	-4.07E-02	-3.52E-02	-1.23E-01
Distribution phase	1.52E-02	1.00E-03	3.36E-02	7.56E-02	5.00E-02	2.74E-02	3.15E-03	1.48E-02	3.26E-02
Energy production in situ	-1.21E-01	-4.11E-03	-7.63E-02	-6.04E-01	-3.10E-01	-1.40E-02	-7.52E-03	-1.63E-02	-2.68E-01
Paper production phase	7.43E-02	5.08E-03	1.23E-01	3.37E-01	2.16E-01	4.74E-02	2.31E-02	2.53E-02	1.73E-01
Pulp production phase	8.76E-02	7.13E-03	1.07E-01	5.62E-01	3.39E-01	4.59E-02	1.17E-02	4.65E-02	1.93E-01
Forestry phase	7.85E-03	4.52E-04	1.68E-02	1.53E-02	1.82E-02	1.69E-02	1.58E-03	4.36E-03	1.26E-02

图 2.1.3-1：生产 1 吨功能单位的纸，不同的阶段产生的不同环境影响

Ren and Huo(2010)的对瓦楞纸箱生产和加工过程的环境影响特征化研究结果显示，加工过程对全球变暖及化石能源消耗的贡献尤为突出(见表 2.1.3-1)。单从温室气体的排放来看，Chen et al. (2014) 研究了纸产品全生命周期中的温室气体排放(主要关注 CO_2 和 CH_4)，包括林木管理阶段、制浆过程（国内外木浆和废纸再生浆）、纸的生产阶段等，采用中国造纸行业典型产品生命周期评价分析的清单，绘制了制浆和造纸过程的能源消耗(详细单位纸产品的温室气体排放清单见表 2.1.3-2 和 2.1.3-3)。Chen et al. 的研究显示，废纸制浆和进口纸浆的制作要比木材直接制浆产生的温室气体高出数倍(Chen et al.，2014)，此结果就对废纸的是否回收再利用提出了疑问。而 Ongmongkolkul et al.(2001)的研究建议则是通过延长纸箱的使用寿命，即通过重复使用纸箱的手段来减少纸箱的生产及用量，从而减少纸箱生产过程对环境和人类造成的危害。当然，回收废纸制浆虽然对环境产生更多不良影响，但不能由此决定是否应该减少回收并增多原木使用，还应该考虑整个回收利用流程和固废处理流程中废纸对环境产生的影响。

表 2.1.3-1：1 m^2 瓦楞纸箱生产加工过程环境影响特征化结果

影响类型	制版工序	印刷工序	成箱工序	总计
全球变暖	1.45	4.03×10^{-1}	2.23×10^{-2}	1.88
水体生态毒性	5.54×10^{-4}	2.67×10^{-4}	5.94×10^{-8}	8.22×10^{-4}
土地生态毒性	5.21×10^{-5}	8.48×10^{-6}	1.35×10^{-6}	6.20×10^{-5}
酸化	1.24×10^{-2}	2.20×10^{-3}	9.81×10^{-5}	1.47×10^{-2}
富营养化	1.90×10^{-3}	3.80×10^{-3}	4.72×10^{-7}	5.62×10^{-3}
光化学氧化	3.29×10^{-6}	2.45×10^{-6}	4.61×10^{-7}	6.20×10^{-6}
固体废物	1.06×10^{-6}	2.77×10^{-6}	8.11×10^{-12}	3.83×10^{-6}
资源消耗	1.45×10^{1}	6.42×10^{-7}	2.36×10^{-7}	3.66×10^{-6}
化石能源消耗	1.45×10^{1}	3.51×10^{0}	7.84×10^{-1}	1.88×10^{1}
人类健康影响(致癌作用)	1.87×10^{-4}	9.03×10^{-5}	2.29×10^{-8}	2.78×10^{-4}
人类健康影响(慢性疾病)	1.41×10^{-7}	6.75×10^{-8}	3.41×10^{-11}	2.08×10^{-7}

表 2.1.3-2：生产 1 kg 浆温室气体排放量

温室气体种类	木浆	商品浆	废纸回收浆
CO_2	117.00	400.62	548.29
CH_4	1.42×10^{-2}	1.23×10^{-4}	5.16×10^{-3}

表 2.1.3-3：生产 1 kg 不同的包装用纸排放的温室气体量

温室气体种类	包装纸	瓦楞原纸	箱纸板	白纸板
CO_2	141.56	82.83	92.00	117.41
CH_4	0.12×10^{-2}	5.31×10^{-3}	6.44×10^{-3}	8.33×10^{-3}

2.2 纸质包装回收过程的环境影响

一般生活垃圾处理可划分为三种方式，即回收利用、焚烧处理与填埋处理。回收利用又可分为三种方式：1)保持其原有使用功能的直接回收利用，如将啤酒瓶等经过清洗后重新作为啤酒瓶使用等；旧衣服、二手物品的再使用；2)不再保持其原有的形态和使用性能，但还保持利用其材料的基本性能，如废金属回收利用、废纸再生、玻璃再生等；3)不再保持其原有的形态、使用性能和材料的基本性能，但还保持利用其部分分子特性等，如生物质有机垃圾的好氧堆肥、厌氧发酵等。针对于废旧纸制品包装的处理，主要以回收制浆再利用为主。我国的废纸整体回收率(直接回收加间接回收)虽不足 50%(Chinabaogao，2017)，但纸箱及纸包装的回收利用率较高，约 9 成能回到造纸厂再加工利用(Zhou et al., 2010)，其余的则以生活垃圾的处理形式(填埋、焚烧等)进行处理，或流入自然环境当中。

电子商务领域的瓦楞纸箱包装通常捎带其他的材料(如电子运单和胶带等)，从而难以实现高效回收，并且容易产生额外的环境影响。Liu et al. (2008) 对用焚烧(发电)、回收(纸浆)、填埋 3 种方式处理相同数量的废弃瓦楞纸箱时的环境影响进行了分析对比(图 2.2-1)。就整体环境影响而言，其严重性是焚烧、回收、填埋依次增大。由于焚烧发电节约了化石燃料的消耗,，故其环境影响为负值；而纸箱回收制成纸浆虽然节约了原纸生产需要的原材料，但由于制浆过程能耗较大，化石燃料和气候变化的环境影响比较显著；而填埋由于长时间厌氧过程纸箱会生成甲烷、氨气等气体，并且纸制包装上油墨可能分解出有毒有害物质，整体对周围环境（水、土壤、大气）均造成污染，因此综合环境影响最为严重。因此，提高纸制包装(甚至所有纸制品)的回收效率，或减少填埋(包含自然流入环境)中的纸含量，可以认为是减少环境影响的有效手段之一。

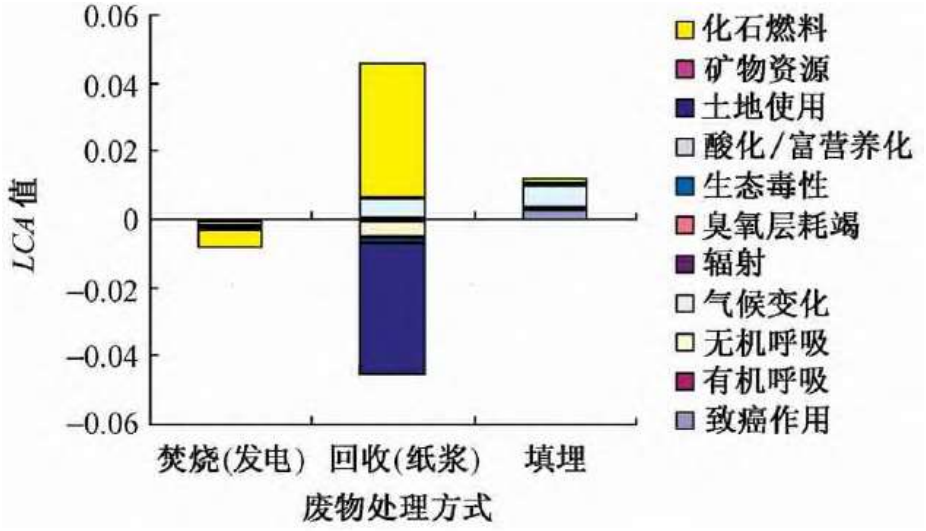


图 2.2-1：3 种废物处理方式环境影响对比

从废纸再生与木材作原料造纸的比较角度看，废纸再生除了可节约大量木材原料，还有其他诸多方面弱化了环境影响。废纸制浆阶段可省去木材制浆中蒸煮、洗涤等工序，减少化工原料、水和能源的消耗，废纸生产 1 吨纸浆可比木材生产节省约 1508 元成本(Zhao, 2005)。废纸再生可减少废水排放以及污染负荷，生产 1 吨废纸浆比生产 1 吨化学木浆平均可减少废水排放约 120m^3，SS 排放减少约 50kg，BOD_5 排放减少约 33kg(Yang，2003)。此外，若不回收利用废纸而进行焚烧或填埋，1 吨废纸焚烧处理可产生 CO_2 1470kg，填埋处理进行厌氧降解可产生 CH_4 730kg。Merrild et al.(2009) 针对废纸回收处理过程中的温室气体排放和全球变暖影响进行了分析，分析架构包括上游间接排放、直接排放和下游间接排放三部分。直接排放主要来自材料回收设施的能源使用，上游间接排放定义为电力、天然气等能源供应和固定设施，下游间接排放来自后续废纸材料的再生产。直接排放的温室气体相当于 1~29kgCO_2/t，上游间接排放相当于 3~9kgCO_2/t，两者与下游排放相比可忽略。下游排放约为 490~1460kgCO_2 每吨废纸；若扣除因废纸再生而节省的原纸生产所排放的温室气体，排放为-1270~390kgCO_2 每吨；再假设节省的木材作为燃料代替化石燃料，则排放为-1850~-4400kgCO_2 每吨，意味着废纸再生相比原木造纸可减少大量温室气体排放。

综上所述，在纸制包装的全生命周期中，造成最显著环境影响的环节即是加工与生产环节，包含原料生产和纸箱生产。在这个环节中，气体污染物主要为化石能源消耗产生的温室气体二氧化碳及甲烷的排放，其次为硫化物、氮氧化物、及易挥发性有机气体的排放；对水的影响主要表现在水耗和水污染(包含化学需氧量、悬浮物、和生化需氧量)；固态污染物主要产生在生产加工过程中。另外，纸制包装(及其他纸制品)的高效回收利用虽然一方面节约了木材、减少了土地利用、避免了部分过程污染，另一方面却增加了能源使用和温室气体排放。这些环境影响有些是地域性的(例如地下水污染)，也有些是全球性的(例如温室气体排放)；有些是易于处理的(例如过程固废)，也有些是难于恢复的(例如能源消耗)。这些影响不停的在消耗资源环境这一公共物品的功能和价值，并且把威胁直接的作用在我们人类身上，而且无论是代内的，还是代际间的。因此，本文将通过深入访谈等手段，进一步研究过度纸制包装的危害，并尝试提出解决问题的多层次可行性方案。

3. 回顾 - 国内外相关政策制定现状及实践经验

3.1 国内纸制品包装相关政策规定汇总

这一部分，对近年来我国出台的涉及纸制品包装的相关政策规定进行了梳理和汇总。党的十八大以来，党中央、国务院以习近平新时代中国特色社会主义思想为指导，深入贯彻习近平生态文明思想和全国生态环境保护大会精神，深入实施大气、水、土壤污染防治行动计划，持续推进固体废物进口管理制度改革，加快垃圾处理设施建设，

实施生活垃圾分类制度，固体废物管理工作迈出了坚实步伐。当前电子商务发展迅猛，随之而来的垃圾处理问题也日渐受到重视。

2017 年 11 月，国家邮政局等十部门联合发文《关于协同推进快递业绿色包装工作的指导意见》，指出要推进源头治理，增加绿色快递服务产品供给，提高快递业包装领域资源利用效率，降低包装耗用量，减少环境污染。提出七项重点任务：一是完善快递业绿色包装法规标准，推动出台《快递暂行条例》。二是增加快递绿色包装产品供给使用，推进使用可循环包装、减量包装和可降解包装。三是实施快递包装产品绿色认证。四是开展快递业绿色包装试点示范。五是做大做强快递绿色包装产业联盟。六是建设快递包装回收示范城市，支持快递企业积极参与再生资源回收利用网络建设。七是强化快递业绿色包装宣传引导与教育培训，普及绿色包装和回收知识。

2018 年 1 月，国务院办公厅发布《关于推进电子商务与快递物流协同发展的意见》。要求强化绿色理念，发展绿色生态链。要求国家发展改革委、环境保护部、工业和信息化部负责促进资源集约。鼓励电商企业与快递物流企业开展供应链绿色流程再造，提高资源复用率，降低企业成本。要求商务部、国家邮政局、原环保部等推广绿色包装，制定实施电子商务绿色包装、减量包装标准，推广应用绿色包装技术和材料，推进快递物流包装物减量化。鼓励电子商务平台开展绿色消费活动，提供绿色包装物选择，依不同包装物分类定价，引导消费者使用绿色包装或减量包装。

2018 年 03 月，国务院《快递暂行条例》第九条明确规定“国家鼓励经营快递业务的企业和寄件人使用可降解、可重复利用的环保包装材料，鼓励经营快递业务的企业采取措施回收快件包装材料，实现包装材料的减量化利用和再利用”。

2018 年 6 月，中共中央国务院发布《关于全面加强生态环境保护坚决打好污染防治攻坚战的意见》，对快递业的绿色发展提出了要求：“推行绿色消费，出台快递业、共享经济等新业态的规范标准，推广环境标志产品、有机产品等绿色产品“。

2018 年 4 月，生态环境部等八部门联合印发《关于开展供应链创新与应用试点的通知》，引导绿色供应链创新与应用：推进绿色消费，加大对绿色产品、绿色包装的宣传力度，鼓励开展“快递业+回收业”定向合作，引导崇尚自然、追求健康的消费理念，培育绿色消费市场。

2018 年 8 月 31 日，《中华人民共和国电子商务法》通过，其中第五十二条为“快递物流服务提供者应当按照规定使用环保包装材料，实现包装材料的减量化和再利用”。

2018 年 9 月 1 日，《快递封装用品》（GB/T 16606-2018）系列国家标准正式实施。对于快递包装箱单双瓦楞纸材料的选择不再作出规定，推广低定量、高强度原材料在快递业的应用。鼓励快递包装箱重复使用。增加可循环利用相关标志的印刷。

2018 年 12 月，国家邮政局发布《快递业绿色包装指南（试行）》，规定了行业绿色包装工作的目标，即快递业绿色包装坚持标准化、减量化和可循环的工作目标，加强与上下游协同，逐步实现包装材料的减量化和再利用。

2019 年 1 月，国务院办公厅印发《“无废城市”建设试点工作方案》，坚持绿色低碳循环发展，以大宗工业固体废物、主要农业废弃物、生活垃圾和建筑垃圾、危险废物为重点，实现源头大幅减量、充分资源化利用和安全处置，选择典型城市先行先试，稳步推进“无废城市”建设。



图 3.1-1 国内纸制品包装相关政策规定汇总（截至 2019 年 1 月 23 日）

综上所述，我国推行和发展绿色物流生态共建的决心坚定的，态度是积极的，步伐是踏实的。通过现阶段的相关政策的制定和实施，我国已经在逐步向更加绿色环保的新阶段迈进，同时也伴随了新问题的产生。纸制品包装多被划归在绿色包装主题下进行探讨，绿色包装也是绿色物流的重要组成部分，这再一次说明了不可以独立的只解决包装问题，而是要系统性的思考，解决整个循环链条的问题。

3.2 国外相关政策制定和实践经验

这一部分将首先介绍 EPR 的起源与内涵。在此基础上，分别介绍欧盟、北美和日本等地区的实践案例，并总结给我国的启示与经验。其实由快递过度包装造成的环境污染和资源浪费问题并不新鲜。以西方国家为例，在电子消费兴起以前的 20 世纪 90 年代，就面临了由于社会经济繁荣，物质主义、消费主义盛行带来的废弃物急剧增多和资源浪费等问题。为了应对日益严峻的个人消费带来的环境污染和资源浪费问题，不少国家出台了以生产者责任延伸(Extended Producer Responsibility, EPR)原则为核心的废弃物管理政策，以减少产品的环境影响并促进资源的循环利用。历经 20 多年发展，以 EPR 为核心的废弃物管理制度无论在理论上还是在实践上均得到了较为深入的发展，在欧盟、美国、加拿大、日本等地区和国家的实施均取得良好成效。在我国，中共中央、国务院 2015 年出台的《生态文明体制改革总体方案》明确提出“实行生产者责任延伸制度，推动生产者落实废弃产品回收处理等责任”。2016 年底，国务院办公厅专门印发了《生产者责任延伸制度推行方案》，新近出台的《“无废城市”建设试点工作方案》也对生产者责任延伸制度进行了强调。此部分将首先介绍 EPR 的起源与内涵。

3.2.1 生产者责任延伸制度（EPR）

生产者责任延伸制，又称为延伸产品责任，该概念最早由瑞典环境经济学家 Thomas Lindhqvist 在 20 世纪 90 年代提出，他将 EPR 定义为一项政策原则(a policy principle)，即通过将产品制造者的责任延伸到产品整个生命周期的各个部分，特别是延伸到产品的回收、循环利用和最终处置，促使产品系统在产品的整个生命周期内向有利于环境的方向改善(Lindhqvist, 2000)。Lindhqvist 认为生产者的全部责任包括一下四类（图 3.2.1）：

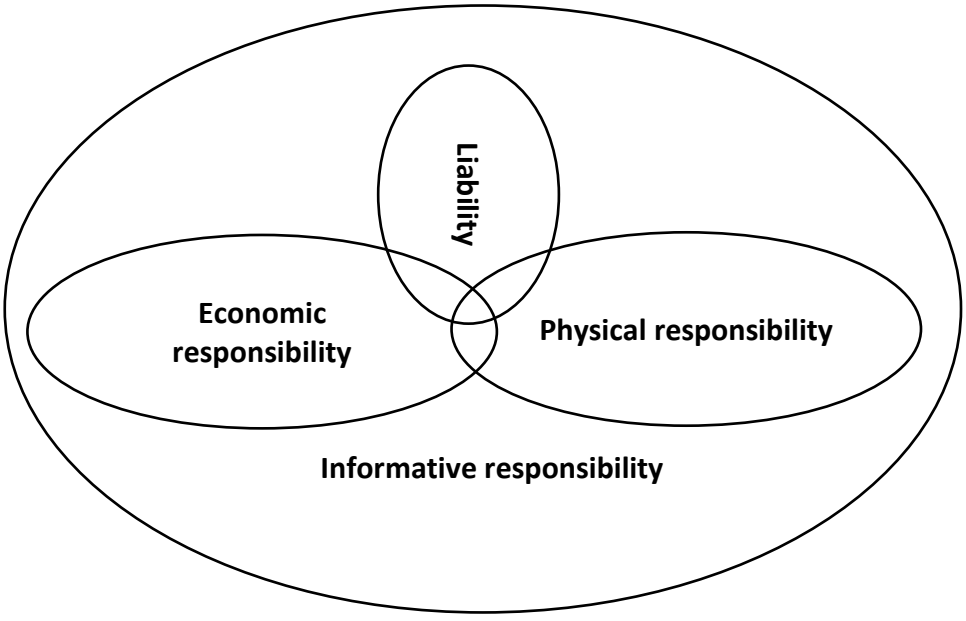


图 3.2.1-1 生产者的产品责任(Lindhqvist, 2000)

（1）产品责任（Liability），指由产品造成的、已被证实的环境损害所产生的责任。该责任的范围由立法决定，可以产生于产品生命周期的各个阶段，包括使用和最终处置阶段；

（2）经济责任（Economic responsibility），指生产者为管理废弃产品支付全部或部分成本，如收集、循环利用或最终处置他制造的产品的成本；

（3）实体责任（Physical responsibility），或者是物质责任、有形责任、行为责任，指制造者有责任参与产品和/或产品影响的实体管理(physical management)。该责任实际包括设计、制造及回收技术的应用、研发乃至回收处理体系的组织与管理责任；

（4）信息责任（Informative responsibility），指生产者提供其制造产品的相关环境特性信息。

继 Lindhqvist 之后，其他学者、政府机构和各种组织也对 EPR 进行了研究，并将其内涵不断扩充与完善。例如，在最初的定义中，生产者被限定为产品的制造者。如经济合作与发展组织（OECD）在一份报告中将 EPR 定义为：产品的生产商和进口商必须对其产品在整个生命周期中对环境的影响承担大部分责任，包括原材料选取和产品设计的上游影响，产品生产过程中的中游影响以及产品消费后回收处理、处置的下游影响(OECD, 2001)。根据此定义，对于一些进口产品，进口商被认定为生产者，从而明确责任主体。然而，这种将生产者和进口商划定为废弃物责任主体的设定在美国并不受欢迎。来自美国的组织、机构和学者大都认为，除了生产者，产品链上还有多个参与者(actors)，如原材料供应者、产品销售者（包括零售商、发行商、供应商）、用户和消费者、废弃物处理者（包括理者、运输、分类废弃物者）、执行监管职能的政府等。产品的责任应按照产品链上各行为主体的角色和作用被公平分配，不主张突出生产者的责任。这种将产品链的各阶段所产生的环境影响由政府、消费者和生产者等共同分担的观点，一般被称为产品全程服务（Product Stewardship）(Gardner, 2013)。这种观点在北美以及澳洲地区比较流行。但有学者认为，在实践过程中，很难将各个主体的责任明确划分，或因主体过多责任被冲淡而导致政策无法施行。因此，过多强调责任分担或划分，会导致 EPR 政策难以执行。

目前来说，关于 EPR 中延伸责任的内容、范围和主体，各个国家或地区的界定不同。如欧洲强调生产者的主体责任，美国则强调责任分担，产品链上的各个主体均有一定的责任。总的来说，现有的 EPR 研究中，大都认同责任分担在 EPR 政策中必不可少，例如消费者有将产品返还到固定废弃物收集点的责任，但是必须有一个主体承担根本责任，而且所有主体的责任都需被明确界定。

3.2.2 国际经验

以 EPR 为原则，不同国家和地区制定了不同的政策以解决产品废弃带来的环境污染和资源浪费问题。有学者将这些以 EPR 为原则的政策工具总结归纳为三大类型（表1），既强制/命令型、经济型、信息型政策三类。不同类型的政策侧重点不同，对责任的分配和延伸范围也存在差异。可以看出，以 EPR 为原则设计废弃物管理政策，有很多的灵活性，并不局限于某一种单一的政策类型。此部分将介绍欧洲、北美和日本等国家和地区的实践经验。此外，由于快递包装隶属于包装类产品，所以在此部分会着重介绍国际包装类材料的 EPR 政策。

表 3.2.2-1 基于 EPR 的政策工具(Tojo, 2004)

名称	形式
强制/命令型政策(Mandatory instruments)	收集和/或回收被弃置的产品，达到收集、再使用（包括重新灌装）和循环利用指标，达到环境相适的处理标准，达到原料应被循环利用的最低标准、产品标准等
经济型政策(Economic instruments)	原料/产品税，补贴，提前收取处置费制度，押金-返还制度，可交易的循环利用额度
信息型政策(Informative instruments)	向主管当局报告，对产品和成分加贴标记或标签，与当地政府就收集网络进行协商，向消费者告知生产者责任/为实现某些废弃物的源头分离需要消费者知道的信息，向循环利用者提供产品构造和所用物质的信息

欧洲

欧洲是 EPR 政策施行最早和最成熟的地区。当前，欧盟已经立法通过了四类产品的 EPR 政策，既包装类（packaging）、报废汽车（end-of-life vehicles）、电子废弃物（WEEE）以及废旧电池（batteries and accumulators），部分欧盟成员国还对地沟油（waste oils）、轮胎（tires）、衣物纺织品（textile）以及杂志书刊（graphic papers）等不同类型的产品出台了以 EPR 为原则的废弃物回收政策(da Cruz, Ferreira, Cabral, Simões, & Marques, 2014)。

以包装类产品为例，德国于 1991 年出台了《避免产生和再生利用包装废弃物法令》，是世界上第一个在 EPR 原则指导下制定的废弃产品管理法。该条例要求生产厂家和分销商对其产品包装进行全面负责，回收其产品包装，并再利用或再循环其中的有效部分。由于德国 EPR 的成功典范，欧盟于 1994 年出台了《包装及包装废弃物指令》（Packaging and Packaging Waste Directive, 94/62/EC），这个法案于 2004 年进行了一次修订。欧盟的包装指令将市政当局收集、分类和循环利用包装废弃物的责任转移到私人企业身上。同时对不同类型的包装材料的回收率进行了限定，其中纸和纸制品包装的回收率要求达到 60%。为应对此法案，不少生产商选择单独或联合成立专门的公司来负责回收和处理其产品废弃物，这类机构被称为生产者责任组织（Producer responsibility organization, PRO）。以德国为例，包装法令通过后，包括零售商、消费产品制造者和包装制造者在内的 95 家公司为免除其直接的实体义务，建立了 DSD 公司(Duales System Deutschland Company)，这个公司会提供一套与政府建立的公共废弃物管理系统相平行的由私人主体运营的系统，因此又被称为“二元系统”（Dual model），被诸多国家和地区所效仿。同时为防止垄断，德国法律还要求生产者建立 2 家及以上的生产者责任组织。这种规定也被认为可以加强竞争，提高回收效率。法国、比利时和捷克等国家则不同，它们的生产者责任组织不再建立新的一套回收系统，而是通过与政府签订各类协议（如外包给政府），利用政府已有的废弃物管理系统来回收和循环利用废弃产品，这种模式一般成为“企业-政府模式”（Industry-municipality model）。另外还有一种“可交易的信用模式”（Tradable credits model），主要在英国使用。在这种模式下，产品生厂商或进口商从生产者责任组织购买“包装回收记录”（Packaging recovery note）来证明其遵守相关法律。在英国，政府负责废弃物的收集工具，生产者责任组织则负责循环利用或处置(Arnaud, 2017; da Cruz et al., 2014)。

自欧盟《包装及包装废弃物指令》实施以来，各国的包装废弃物回收利用率基本保持一个逐年增长的趋势，以纸制品包装为例，欧盟 28 国的平均回收率从 2005 年的 75.7%增长到了 2016 年 85%（表 2）。

表 3.2.2-2 欧盟部分国家 2006-2016 年纸制品包装的回收率（%）(da Cruz et al., 2014)

国家/年份	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
欧盟 28 国	73.3	75.7	78.4	80.9	83.4	83.5	83	83.9	84.7	82.5	83
比利时	83.3	89.1	92	89.4	88	89.8	90.4	89.8	89.1	90.6	90.7
德国	82.1	80.2	80.2	87.7	91.1	90.2	88	87.6	88.2	87.3	85.7
西班牙	69.2	71.4	70	73.4	76.7	76.1	76.6	77.8	75	78.2	76.9
法国	80.9	84.6	89	86.9	85.6	91.9	88	91.8	95.8	94.1	92
意大利	66.6	66.6	69.7	73.8	80.4	78.7	79.5	84.5	84.6	78.7	79.7
荷兰	71.7	94	93.8	96.4	94.8	89.9	88.6	88.9	88.2	85.9	85.4
奥地利	86.4	87	83.5	85.4	84.8	84.5	84.5	84.9	84.3	84.9	84.9
瑞典	72.2	72	73.5	74.1	74.2	69.6	75.5	76.8	78.4	79.3	81.7
英国	74.2	78	79.3	79.7	83.9	81.9	84.8	86.5	89.4	73.1	77.2

亚洲

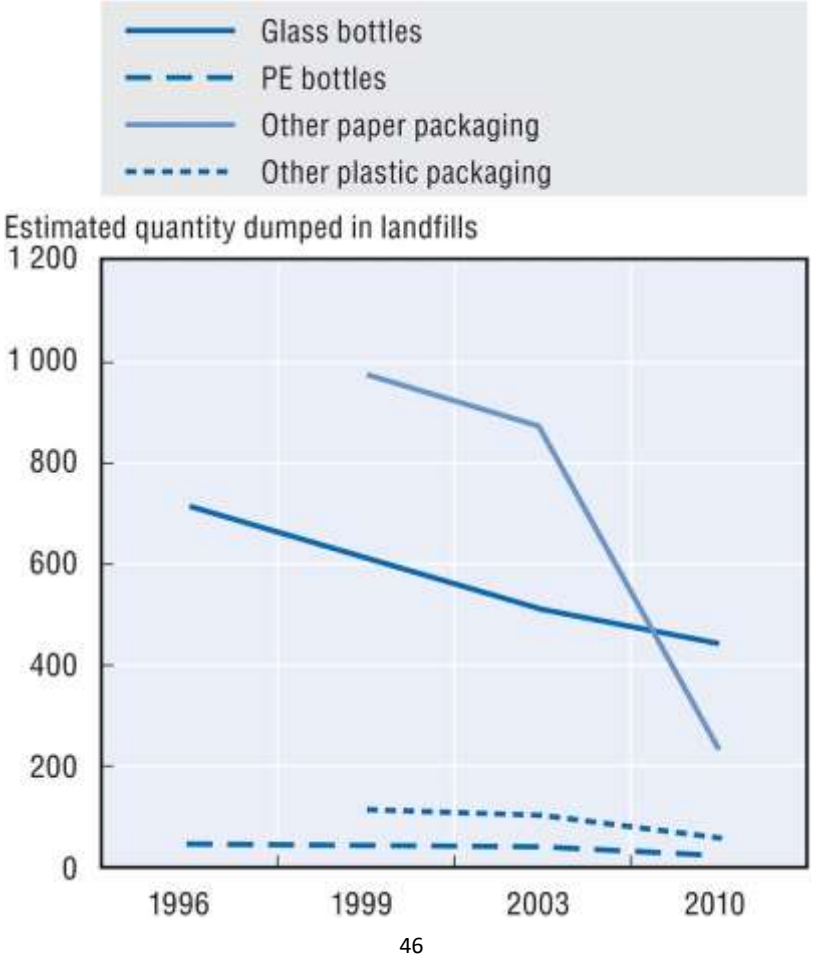


图 3.2.2-1 日本各类包装类废弃物的填埋量(OECD, 2016)

日本、韩国以及我国台湾地区也是较早一批实践生产者责任延伸制度思想的国家和地区。这其中，日本最早接受生产者责任延伸制度思想的国家，它的相关立法系统和政策也相对成熟。自 1995 年其，日本先后颁布了《容器和包装分类收集和循环利用促进法》和《特定家电循环利用法》两项以 EPR 原则为核心的废弃物管理法案(陈晨, 2007)。根据该法案，市政当局负有实体和经济责任去收集消费者丢弃的包装废物。生产者或销售者则负有经济责任去回收利用或处理政府收集的包装废弃物。日本政府成立了一个专门负责回收和处理废弃物的生产者责任组织，即日本容器和包装回收协会。这个组织负责将具体的回收利用行为外包给合格的回收者/公司。同时规定，生产者可以参与生产者责任组织的设立，且允许多个生产者责任组织的存在。但实际上，目前只有日本容器和包装回收协会一家生产者责任组织存在。此外，日本政府还负责提高公众意识，并通过教育活动促进适当的分类。原则上，所有生产者都需要标记其产品以便于废物分类。经过十多年的执行，日本容器和包装的填埋率显著下降（图 2），同时各类包装的也逐年提高。

北美

美国和加拿大也是较早实践 EPR 制度和政策的国家。以美国为例，目前有 10 多个州设立了饮料瓶回收法案，通过使生产企业为饮料瓶收集和回收付费，使多余的塑料垃圾从填埋场移出。通过使生产企业为饮料瓶收集和回收付费，使多余的塑料垃圾从填埋场移出。除塑料瓶外，美国的 32 个州也已有特定产品的 EPR 法规，使生产者为废弃电视机和其他电子产品负责。加拿大在实施生产者责任延伸制度中将它作为一种更广泛的市场经济的管理手段，除了用于外包装废物外，还用于其它的一些废物管理，如：废电池、电子设备、耐用消费品、交通工具以及汽车轮胎等(Gardner, 2013;

Hickle, 2014)。例如，加拿大不列颠哥伦比亚省从 1992 年制订了有关废润滑油处理的相关条例。在该规定作用下每年有 4 千万升以上的废润滑油通过生产者责任延伸制系统得以回收。1994 年该省又通过了关于废油漆的生产者责任延伸制规定，1997 年有关溶剂、可燃液体、家用杀虫剂、汽油和药品的法规也建立了起来。不列颠哥伦比亚省通过引入生产者责任延伸制，地方政府的废物管理费用显著下降。

相比于欧洲和日本的国家层面的强制性立法规定相比，美国和加拿大更倾向于各州政府探索废弃物的各种管理途径。尽管两个国家的州和地方有 EPR 立法的动力，但距离建立 EPR 联邦性法律仍然很遥远。此外，两个国家的多数地方政府的法令规定多是鼓励生产者而非强制要求生产者负责。最后，在北美地区，更强调将产品的回收利用责任按产业链中的角色公平分配，而非强调生产者的主体责任。这种做法看似公平，实则稀释了生产者的责任，并降低了激发其改进产品设计的动机的可能性。

3.2.3 经验总结与启示

世界上各个国家执行 EPR 政策有成功也有相对比较失败的案例，综合来看，在制定 EPR 政策时，以下几点应着重考虑：（1）在立法层面，要明晰 EPR 的概念和目标（EPR 目标的目标并非回收利用产品，而是促进生产者从全生命周期角度出发，改进其产品设计，以使得其产品的环境影响减量化）；（2）责任可以分担，但各个角色必须责任都需被明确界定，这个责任包括产品的实体责任、经济责任和信息责任；（3）必须建立一个明确和稳定的框架，以确保公平竞争，并为所有人提供充分的监督和平等的规则，尤其是要防止生产者责任租住的垄断；（4）要保证 EPR 政策相关信息的透明度，如政策的执行情况、PRO 的资金来源去向等等；（5）政府或相关管理机构应负责监督和审查 EPR 政策的执行情况，并应确保有适当的行政执法手段来严惩违法者。

4. 观察 - 行业专家深度见解与观点

第一部分，我们就电子商务消费领域中包装产业链的全景进行了详细的阐述，并分析了每一环节上可能产生的环境影响，可以明确的看到解决过度包装问题降低其所带来的环境影响与每一个利益相关方都是息息相关的。

一般来说，多层次的可行性解决方案的提出一定需要综合考量各利益相关方的观点，倾听不同的声音和诉求，在实际情况下加以整合和调整，才有可能找到真正得以落地实施的计划与策略。电子商务流转环节的行业内专家是来自大型电商（自营）平台和领先物流企业的主要负责人们，在这一核心的承上启下的环节中，他们同时做为上游包装制造业和商品制造业的采购者以及下游个体消费者的供应商，对这两大部分的主要观点和行为表现都有很好的把握和深刻的洞察，并且能结合其自身的行业情况，就我们的问题给出全面的解答。

因此，在这一部分，我们通过对全产业链中承上启下的利益相关方 – 电子商务流转环节的行业内专家进行一对一深度访谈，结合现状和文献加以分析，通过归纳与总结获取多个专业观点与深度洞察，以描绘出我国过度包装现象更为全面的现状。

本报告主要针对产业现状进行阐述和分析，不包含消费者心理调研，因此未将普通个体消费者针对过度包装的观点纳入考量。

4.1 践行生态文明建设主体责任 - 减少“过度包装”的责任在每一个环节

“过度包装”问题是系统性的问题。因此解决方案也必须是系统性的，解决问题的责任在系统的每一个环节，各环节必须明确其责任并承担责任，在互信/互重/互助/互惠的基础上，逐步推进，达成一致。

首先，各利益相关方应该就“没有绝对的过度包装，解决过度包装的责任在每一个环节”这一事实达成共识。在这一共识的基础上，通过公开透明的对话了解各环节

的主要诉求和决策原因，充分理解，建立互信。目前从物流角度来说，普遍意义上的“过度包装”是存在的。由于物流运输过程中的操作不规范所引起的包装损坏，迫使原本包装的厚度和胶带的使用量在无形之中增加了。有关部门曾就快递运输过程中的包裹被平均抛摔次数和高度进行评估，发现大型物流平台在这一环节几乎不存在过度抛摔情况，这是其智能分拣系统和分拨中心优化的所带来的成果，但是在中小型物流企业中这一情况较为严重。不难理解，商品供应商和快递行业所面临的同行竞争是日益激烈的，消费者的满意度是他们所认为的消费者的首要追求，纸制品包装的选择自然就靠后了；而消费者自身对快递行业的不信任造成了其对快递纸制品包装的过度诉求，这从另一个侧面激化和加剧了“过度包装“的产生。因此，要破除这种恶性循环将其转化为良性，需要各方就协同解决包装问题达成共识和信任，相互理解彼此诉求，加速改善现存问题，才可优化解决方案。

系统性的解决方案建构在完整清晰的利益相关方网络上，离不开各利益相关方的协同合作。在相互理解和信任的基础上，携手共进，互惠互利，一起寻找符合各方诉求的解决方案是势在必行的。举例来说，从商品供应商和电商销售平台的视角来看，由于商品性质和售卖诉求的差异化，供应商和经销商之间的衔接和沟通则成为了解决或避免“过度包装”的主要因素。商品本身存在拆零销售，一些特定种类的商品其本身用于销售的外包装具有提升商品形象的附加作用，并非运输包装。在这种情况下，便产生了二次包装，而消费者最终会将两种包装全部移除，这就形成了“过度包装”。一些普通的日化类商品虽然可以不进行二次包装，但是其本身的包装不利于快递面单的粘贴，所以不得已时还是需要有外包装。这一原因所引起的“二次包装”，一些供应商和经销商已经开始通过积极的相互沟通寻找解决方案，从供应商端对商品外包装进行优化，符合后期销售和运输的双重标准。2017 年 6 月，京东携手宝洁、雀巢、农夫山泉等品牌商共同发起了“青流计划”，减少电商二次包装，预计到 2020 年，将减少供应链中一次性包装纸箱 100 亿个，相当于 2015 年全年全国快递纸箱的使用数量。

系统性的解决方案在执行落地的过程中，不可避免会显现出诸多问题，增大推行阻力。仅仅通过相互信任来维系解决方案系统的稳定性是不足的，各环节间的相互监督的必不可少。值得深思的是，消费者角色在监督促进环节，对其他利益相关方所产生的影响是可持续的。消费者群体是稳定存在和日益壮大的。作为被服务的对象，其需求和建议会源源不断的督促和迫使服务提供者作出改善；作为普通公民，其需求和声音也被政府机构聆听和重视，得益于此，消费者可以产生着可持续的正面影响。因此，如何合理发挥消费者的监督和促进作用是值得我们思考的。

4.2 正确理解和认知“过度包装”是解决问题的一个关键

“过度包装”这一概念的主观性决定了其不可被严格界定的事实，因此一味纠结如何界定其存在和定义是无意义的。在这种情况下，各利益相关方的视角都被正确的倾听和理解，在此基础上建立相互信任和尊重，才能进一步推动全产业链协作改善“过度包装”问题。对于商品供应商来说，消费者眼中的“二次过度包装”，在一些特定商品的情景中其实是必须的，因为这是维持品牌形象的附加产品；对于纸制品包装制造业，生产纸箱的尺寸，层数和抗磨碎程度等取决于市场的需求；对于销售和物流平台，客户的满意度和包装成本是最先被考虑的；对于消费者，对快递包装诉求的异质性很高，同一位消费者在购买不同的商品类型时有可能会对商品本身的包装和快递的包装出现差异化需求，不同消费理念与价值观的消费者则更容易产生差异化需求。在众口难调的情景下，充分倾听各利益相关方的声音，充分理解各利益相关方的视角，充分沟通各利益相关方的诉求，在一个公开透明的对话环境中，进行协商和妥协，最终达成一致，找到最适用于当下的解决方案。

目前，大众对于快递业的污染问题的认知和理解，其实也存在“过度”的现象，一味过分扩大纸制品包装的问题（例如“过度包装”“绿色包装”等），容易导致大众对其他环节产生的污染问题忽略，例如在物流运输过程中所产生的污染气体排放和

能源消耗问题也是十分严重和亟待解决的。大众能意识到快递包装方面所带来的环境危害固然是好的，但是也不能过分理解和过分施压。因此，当我们通过宣传教育等手段培养环保意识时，应当更加全面的审视问题，将大众视野拓宽，从源头上将“节约资源”“减少能耗”等环保意识提高起来。

4.3 促进完成物流快递行业中纸制品包装的统一行业规范

目前，物流快递行业中包装的统一行业标准或规范是缺失的，这一标准是必要的，但是包装标准化受限制于多重因素，“一刀切”的做法显然是不可取的。其实，包装的操作规范是存在于各企业内部的，在成本核算方面已经得到优化，且十分细致，可以落地。然而，实现大面积推广是需要将更多要素纳入考量。最首要即是企业类型和体量，企业自身是否有足够的能力完成标准，其次是厂商和客户诉求如何平衡和满足等等。因此，形成行业标准固然重要，但这离不开政府和有关部门在政策制定上的引导和支持。

物流快递行业中包装的统一行业标准或规范所涉及内容应当尽量全面，广泛覆盖。单就纸制品包装而言，其使用和废弃涉及多种材料，因此从最基础的快递纸箱层数，到胶带宽度和使用长度，到印刷物料成分等都应当有相应的规范。例如胶带作为纸制品包装中不可回收的部分，其在末端处置中所带来的问题是值得关注的，标准化胶带质量与宽度，或者推行无胶带化一体纸箱都是解决这一问题的策略。另外，从环保角度来说，较之纸制品包装，对塑料包装的限制应该更加严格，因为其所带来的污染问题是更为显著和不可逆的。

4.4 成熟的智能化绿色仓储和物流体系助力解决“过度包装”问题

很多人谈到“过度包装”，都会首先想到“大箱小用”或者“一单多箱”的现象。其实这一现象，在目前的智能化绿色仓储和物流优化下，已经很少存在了。通过“优化核心商品布局与仓储”“智能选包（装）”“物流路线优化”等高科技手段已经尽量减少了这些现象所带来的“过度包装”。利用大数据分析测算，根据消费者偏好储藏商品，减少不必要的转运环节；利用智能化系统自动分析测算每一单商品的包装方案，减少不必要的包装成本；利用智能物流路线优化，减少运输过程中的能耗。这些智能化技术目前已经被大规模的应用，并且逐渐趋于成熟，只是系统仍处在发展和优化的过程中，故障和问题仍然存在，这也是我们需要正视的地方。2018 年，菜鸟网络依靠大数据推出“智能装箱算法”，并向全行业输出了这一项平台级技术，帮助实现箱型更匹配、装箱更紧凑，满箱率提高到 70%。自推广以来，已经累计优化超过 5 亿个包裹，相当于节省了 1.15 亿个邮政 6 号纸箱，减少的碳排放超过 1.5 万吨，好比多种了 848044 棵梭梭树。

4.5 “过度”纸制品包装问题的解决方案多样化

自 2013 年起，各电子商务消费平台和物流平台就已开始着力实现电子商务消费领域包装绿色化进程，包括顺丰“智慧包装实验室”，菜鸟网络“绿动计划”，京东“青流计划”，苏宁“青城”，海尔“日日顺”，德邦“包装实验室”等。计划中与减量化相关的方案与措施，很大程度上促进了“过度包装”问题的解决。解决方案的多样化是有目共睹的，执行过程中所显现出亟待优化的环节也差别众多。

4.5.1 促进前端优化纸制品包装设计与应用 – 更环保/可循环

随着绿色物流发展战略的提出，优化纸制品包装设计制造与应用已经成为趋势，在各利益相关方不懈的努力之下，已经初见成效。

在保证纸制品包装质量的前提下，减少材料利用，提升制造工艺，降低其所带来的环境影响是纸制品包装优化的第一步。2014 年，顺丰开始将纸箱、文件封、胶袋满版印刷改为无底纹印刷，减少油墨用量约 70%，按每年印刷 1.5 亿个物料计算，约可减少 750 吨油墨的使用 2018 年，顺丰正式发起“丰景计划“，开发“丰系”包装，以保质减量为基本原则，对纸箱、快递袋、文件封进行减量化轻量化改革。现阶段推广的丰系包装已覆盖超过全国 45 个地区，总使用量近 40 亿个，新包装的成本对比之前降低 4%-30%不等。2018 年顺丰共投入数百万元用于丰景计划各类包材的创新研发，丰景计划共降低了 9901 吨的碳排放，相当于减少 9.9 万颗树的砍伐；2017 年 5 月，菜鸟及其合作伙伴研发定制的可完全降解快递袋在天猫超级品牌日上进行使用，可降解快递袋使用合成聚酯材料(PLA, PBAT)生产，可以在自然环境下完全降解。胶带的使用同样也受到关注，作为不可回收的部分，减少胶带的使用或者找到更佳的替代方案（例如一体化封装纸箱）是主要趋势。为了减少封箱胶带的使用，菜鸟在仓配体系内推广积极免胶带的“拉链式”纸箱来替代传统纸箱。2015 年京东就已经对胶带进行优化，在不影响快件包装效果前提下，将胶带的宽度由 53mm 缩短至 45mm，缩短了 15%，每年可减少胶带使用量 500 万平方米；这一计划让京东在 2016 年减少了至少 1 亿米的胶带使用，可绕地球 2.5 圈。

不仅仅是末端的回收再利用，从物流包装设计上践行“可循环使用”理念也已经成为大趋势。2017 年 12 月开始，京东物流可循环使用的“青流箱”陆续在北上广杭等十几个城市投入使用，“青流箱”可循环使用 20 次以上，单次使用成本相比普通纸箱可节省 30%以上。从 2016 年开始，顺丰启动“可循环”包装材料的研究。2018 年，丰·BOX 循环包装箱（已获 15 项国家专利）在全国范围内投入使用。目前已投入 50

万个丰•BOX，实际已使用 40 多万个，累计循环次数近 500 万次，使用率超过 80%，单个丰•BOX 的最高循环次数达 41 次，且还在持续循环使用中；覆盖全国 24 个城市（地区），其中囊括所有一线城市、9 个二线重点城市； 2019 年顺丰计划投入 300 万个“丰 BOX”，预计节约纸箱 1.5 亿个。德邦快递提出绿色折叠循环箱的概念。快递员携带这样的循环箱上门取货，将客户的货品装进循环箱，等货品送达之后，再将循环箱收回，重复利用。2018 年 2 月，菜鸟首批“菜鸟循环快递箱”投入使用，为可折叠设计，使用“插拔式”指环锁扣设计代替胶带，单个可循坏超 20 次。

毫无疑问，纸制品包装设计与应用的不断优化让人们看到了减少“过度包装”，实现绿色物流的希望，而在这些优化的背后，不可忽视的是行业的巨大投入和潜心经营。从先期的研发设计成本，到后端运营维护系统建设成本，纸制品包装的生产和流转都涉及到大量的人力物资的投入，且持续周期较长。这形成了中小企业实现绿色物流的壁垒，进一步为我国全面减少“过度纸制品”包装所产生的环境影响造成阻碍。

4.5.2 促进消费者末端纸制品包装回收 – 平台逆向物流 vs. 消费者自主应用

纸制品包装的回收利用被普遍认为是最有效的资源回收利用途径，如何促进消费者回收或利用纸制品包装成为重要议题。

2016 年 8 月菜鸟网络“绿动计划”启动开展天猫超市的纸箱回收。目前，天猫超市纸箱回收服务覆盖北京、上海、广州、天津等全国 10 个重点城市，在覆盖区域内的快递员会在投递包裹的同时，征求消费者意见是否愿意将家中多余天猫超市纸箱回收，征求许可后，快递员会将回收纸箱带回配送站点，由站点统一作检查和清理，符合二次利用的纸箱将贴上标签继续送回菜鸟仓库做二次利用，而不符合要求的则会交付专业处理公司；以菜鸟网络智慧物流平台为基础，在高校菜鸟驿站设立“绿色行动包材回收区”试点；2018 年双十一期间，菜鸟“回箱计划”在全国百城约 5000 个回收点启动，在 11 月 8 日到 11 月 14 日间回收超过 500 万个纸箱。为推广回收台的利用率，

菜鸟连续推出创新模式：联合全国近百所高校，发起纸箱循环使用绿色倡议，打开高德地图就可以搜索距离最近的绿色回收台;还可以通过菜鸟裹裹、支付宝等手机软件在线互动，参与线下植树等公益活动。

2017 年 3 月起，京东“青流计划”升级内部收回系统，为客户提供有偿回收闲置纸箱业务，由快递员进行回收返回京东仓储物流体系，激励消费者将纸制品包装返还回收。2018 年双十一期间，苏宁物流推出共享快递盒回收站活动，依托苏宁小店助力社区快递包装回收利用。2017 年双十一期间，海尔“日日顺”物流发起“不同凡箱”活动，号召消费者对大件物品包装箱进行改造，实现其在日常生活中非快递包装的二次利用。顺丰速递开展纸箱回收行动，通过派件主动宣导客户回收、客户线上微信预约、开发可循环使用包装箱“丰箱”等多元化回收方式回收纸箱。

消费者在末端对纸制品包装进行回收的动机主要分为两类，一是纸制品包装作为高附加值垃圾可以获得经济利益，一是纸制品包装作为日常用品可以进行其他利用。在鼓励消费者返还纸制品包装形成逆向物流还是鼓励消费者形成资源优化利用意识实现自主二次应用之间，总是有不同的声音存在。因此，如何在这两者之间作出平衡与选择，是需要进一步协同商讨的。

4.6 国家政策制定和执行是推动和维系这一进程的关键因素

长期以来，我国都将绿色发展作为国家发展的重要战略之一，自党的十八大以来，为推动生态文明建设进程，一系列相关指导意见和文件的出台，引导着电商行业和物流行业在减少“过度包装”问题上所采取的措施。首先，应当保证相关规章制度切实有效的落地与执行。2018 年 9 月 1 日，我国开始正式执行新修订的《快递封装用品》系列国家标准，标准中对纸制品包装从绿色化，减量化和循环利用方面也作出了相应的指示，大大助益了行业标准的制定和推行。在这个良好的开局过后，接下来如何进一步落地和执行新标准，是十分值得关注的。

同时，政策制定过程中在对国外优秀政策案例进行借鉴时，将优秀经验放诸本土，充分将我国国情纳入考量是必要的；政策的制定要应当尊重市场和经济的原则，通过激励的方式进一步推动企业和利益相关方，从战略层面以绿色物流为导向进行顶层设计。

5. 展望 – 观点与建议

5.1 治理观点

基于前期背景调研中所呈现出的现状和趋势可以看出目前中国政府对于过度包装表现出了较大的重视，但要改善过度包装问题所造成的环境需要从由以下三个层面进行宏观调控：

（1）行业治理方面，具体可从技术创新和行业伦理两方面进行治理，在技术创新方面，技术创新是缓解过度包装问题的直接措施，目前国内电商企业已尝试使用智能仓储和智能投递技术最大程度上减少投递路程上所带来的环境问题，未来应加强在过度包装方面的技术创新，如在包装材料和填充材料方面的研发，使用诸如珍珠棉、减震纸球等环保填充材料，同时降低对塑料袋及胶带等非环保包装用品的使用，进一步降低过度包装对环境的影响；行业伦理方面，应在商家、消费者以及设计等多项生产环节中树立环保意识，普及过度包装的危害性。

（2）环境治理方面，具体可从公共管理的角度上进行治理，一方面要积极完善相关立法，在诸如《包装法》中进一步完善对过度包装的界定，给予生产厂家正确的标准规范，形成法律依据；另一方面应加大法律惩处力度，规范执法过程的严谨程度，对于部分屡教不改的过度包装行为可采取强制措施，使得相关法规得到切实有效的落实。

（3）社会治理，解决过度包装问题需要包括消费者、业主团体、垃圾回收等多方面的共同协作，因此抵制过度包装，提高社会的整体意识不可忽视，可通过电视、网络等方式向大众普及过度包装的知识、危害，改变社会对于“包装既是品质”的错误认识，提升社会对过度包装的正确认识。

5.2 政策建议

针对进一步减少过度包装所带来的环境污染问题，结合国内外政策制定情况和行业专家深度见解，研究组就这一问题的潜在解决方案提出以下几点以供参考：

一是将优秀环境思想和经验结合中国环境进行本地化转换。以生产者责任延伸制度(EPR)为例，既是一种方法，更是一种思维，其内核聚焦在责任的划分，因此对责任边界的划分，操作灵活度的把控，责任主体的明晰都是需要我们深度本土化的。例如结合相关行业专家提出的“践行生态文明建设主体责任 - 减少“过度包装”的责任在每一个环节“观点，我国在进行责任主体明晰时，应当将各利益相关方都纳入考量，包括消费者，这即是符合我国国情的，也是符合广泛的 EPR 原则的。

二是重视独立第三方的观点及建议。在政策制定环节中，以 NGO 和研究机构为代表的第三方能够提供更加客观的视角和支撑证据，有利于平衡和维护各利益相关方，同时可增进政府相关部门与各利益相关方的有效沟通。此外，由于过度包装问题涉及专业领域较多，第三方能够起到良好的平台作用，推动跨界研究与合作，为解决过度包装提供更完善的解决方案。

三是政府与市场形成合力治理过度包装。形成以政府为主导，多元主体并存的治理模式，可尝试研究和推动在过度包装方面的 PPP 模式，在治理过程中引入市场机制，一方面减轻政府在此项工作的开支，降低政府预算压力；另一方面，通过引入多元主体，使项目参与各方整合组成战略联盟以协调不同方面的利益，使得相关政策更容易进行推动，同时也可起到降低风险，提高公共服务质量的作用。

四是系统培养和改变消费者原有纸质包装的回收习惯。如前文提到，消费者在末端对纸制品包装进行回收的动机主要分为两类，但并不局限于此。从行为学角度来看，形成和影响消费者对纸制品包装的回收行为的决定性因素远不止动机一项。现有的理

论模型，都不足以充分解释这一行为的产生机制和决定性因素，这是由人群的异质性所决定的。因此，在试图促进消费者对纸制品包装的回收行为时，应当首先认识到解决方案必须是多样化的，并将视野拓宽从多个维度考量，在此基础上找到适合特定人群的行为改变决定性因素和可能的行为模式。

五是重视相关数据开放与收集，以数据为基础进行监管。相关行业与企业在进行自身产品或项目所带来的环境保护效应时，应当并必须尊重事实，不可起到误导消费者的作用，同时应当受到适当程度的监督监管，目前大多产业生产环节缺少监控和记录，部分数据也存在涉及保密而不能公开的情况，建议通过全产业链生命周期评估更加准确的展示各环节中的环境影响，同时基础数据的保存和分析应用可以为设计“过度包装”解决方案提供量化支撑，为评估解决方案成效提供背景支持，为宣传和认识绿色化进程提供有力证据。

六是进一步加强公民环保意识，闭环环保相关环节。各利益相关方所关注的重点仍有待聚焦，企业更多的将履行社会责任作为宣传手段，而消费者关心的则更多的是自己所购买物品是否完好无损。在各环节均未形成较强的环境保护观念和意识，将绿色生产绿色消费深入深化时，是无法形成有效的环境保护闭环。

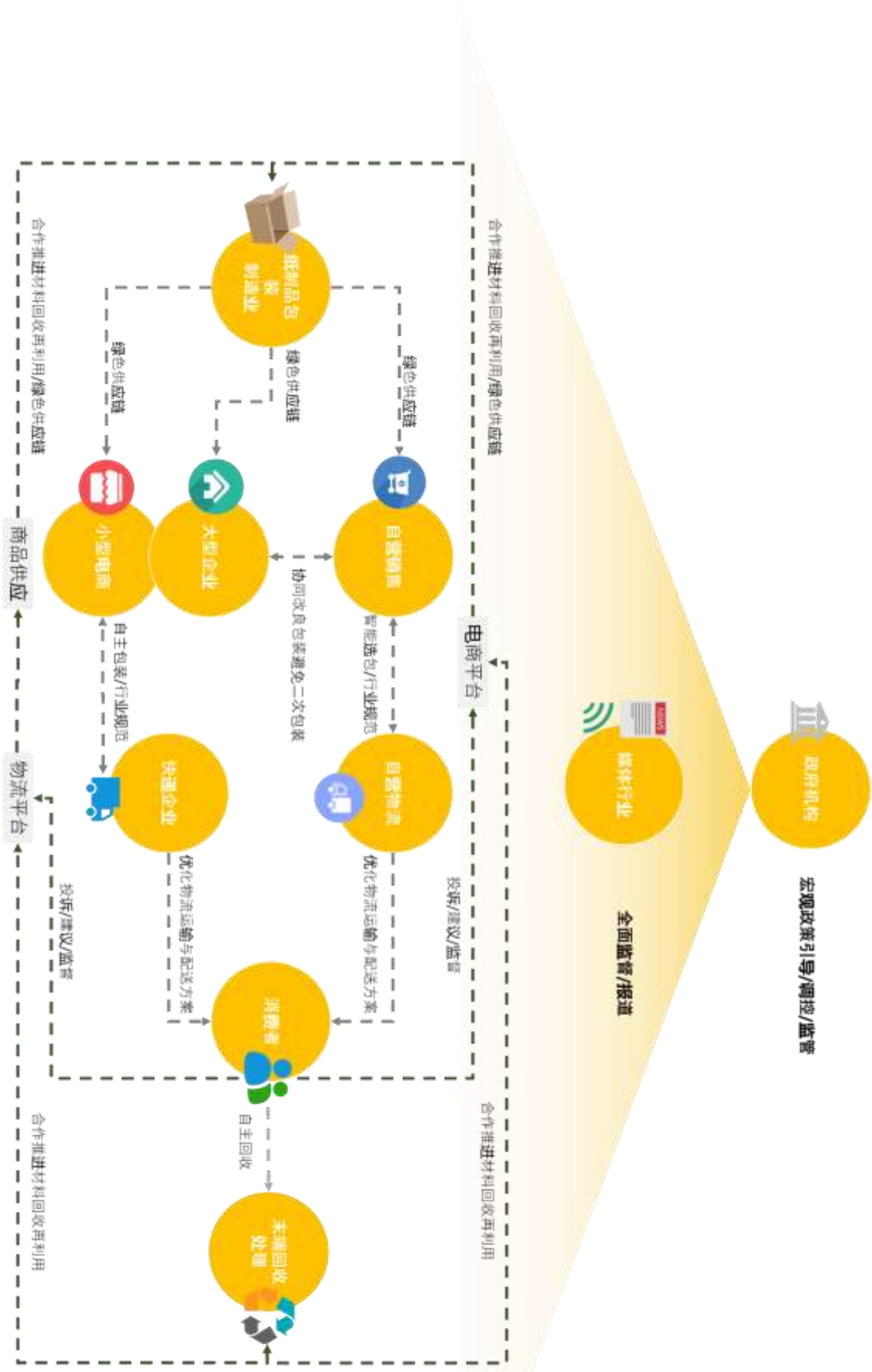


图 5.2-1 电子商务消费中过度纸制品包装的潜在解决方案框架

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“Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs. It contains within it two key concepts: The concept of 'needs', in particular, the essential needs of the world's poor, to which overriding priority should be given; and the idea of limitations imposed by the state of technology and social organization on the environment's ability to meet present and future needs.”

— World Commission on Environment and Development, Our Common Future (1987)

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Introduction

This article is aiming to show the over-packaging issue and the environmental hazards it brings, and further discuss possible solutions. Therefore, the article will starting from the development status of domestic and foreign e-commerce consumption field, trying to understand the production, consumption status and development trend of the common paper packaging used in this field. Meanwhile, the research progress on the potential environmental impact of this particular type of paper packaging was teased out and summarized. In addition, through depth interviews with industry key opinion leaders in relevant industries to collect expert opinions and arguments, we try to extract the current major industry development directions and future research concerns on this topic. At the same time, it reviews and summarizes the relevant policy-making and excellent practical cases at home and abroad. Finally, by integrating the research contents of the above four parts, based on the current situation and development trend of paper packaging in the field of domestic and foreign e-commerce consumption, pondering the potential environmental impact of this particular type of paper packaging in an all-round way, combining experts' opinions in the industry and the field of research, and referring to the current excellent cases in other countries and regions, this article puts forward prospects and feasible suggestions for the over-packaging in the current e-commerce consumption field in China.

In recent years, China's e-commerce industry has developed rapidly. The express delivery and logistics industry, as an important support of the e-commerce industry, has risen simultaneously. According to the statistics from the State Post Office, China totally sent 50 billion express shipments in 2018, consuming about 14.3 billion packing cases, 5.3 billion woven bags, 24.5 billion plastic bags, 5.7 billion envelopes and 43 billion meters of adhesive tape. In the circulation of commodities, the outer package of products has effects of protecting commodities, beautifying commodities, facilitating storage and transportation, guiding consumption, increasing added value, etc. (Zhai et al., 2010). However, with the increasing demand for packaging from producers and consumers, the problem of over-packaging is becoming more and more serious. “Over” can be reflected in consumables, quantity, volume, cost and other aspects, which can be roughly divided into two aspects: over-packaging of commodities and over-packaging of logistics. However, it is difficult to define the concept of over-packaging, which is relative to moderate packaging (which is also difficult to define accurately). Bi (2008) defines moderate packaging as a reasonable and appropriate commodity packaging, with proper protection function, suitable materials, proper volumes and capacity,

reasonable cost and complete logo tag. In the National Standard *"Request for Restricting on Over-packaging of Food and Cosmetics Commodities"* issued by the General Administration of Quality Supervision and Inspection and the State Standards Commission in 2010, a relatively quantifiable guiding standard for over-packaging on food and cosmetics was given. The Standard shows that the excessive package refers to the package that exceeds the normal functional requirements of packaging, and its packing void rate, packing layer number and packaging cost exceed the necessary level. The limiting indexes in packaging of beverage, wine, pastries, tea, grain, cosmetics and so on are put forward in the Standard. For example, the void ratio of tea packaging shall not be higher than 25%, the number of layers of packaging shall not be more than 3, and the sum of all packaging costs except the initial packaging shall not exceed 12% of the sale price of commodities. However, the national packaging standards for other commodities are relatively insufficient, and the relevant standards shortage of the secondary packaging in the rapidly rising logistics industry is even more prominent.

Over-packaging will cause a lot of harms, which can be summarized into four aspects. On the one hand, over-packaging causes great waste of resources. Paper, glass, plastic and metal are the main raw materials in packaging industry. But the production of these materials comes from trees, oil, steels and so on. To a certain extent, over-packaging and ineffective recycling waste resources. On the other hand, the failure to effectively recycle packaging waste aggravates environmental pollution. According to many media reports, the output of domestic waste in China exceeded 400 million tons in 2017 and is increasing year by year. Packaging waste accounts for about 30% of solid waste (Zhou, 2009), and there is a huge gap between the annual production and disposal of solid waste, which results in the accumulation of refuse and has a huge impact on the ecological environment. Furthermore, the over-packaging of commodities infringes the interests of consumers. After paying the necessary commodity prices, consumers cover the extra huge packaging cost which includes not only the excessive packaging part, but also the raw material processing, production, transportation and a series of downward transmission costs in “upstream links”. Finally, over-packaging induces bad social atmosphere and hidden corruption. Over-packaged festival gifts often become "shade cloth" for bribery, using the extra space in the packaging to hide valuables.

Paper products accounted for more than 40% of the total output value of packaging industry among all kinds of packaging products (CHYXX, 2017). With the rapid development of e-commerce and logistics transportation, people's dependence on online shopping is also increasing. In 2017 alone, China's express business volume reached more than 40 billion pieces, increasing 28% over the same period last year,

accounting for more than 40% of the world's share. Paper packaging supply and demand are unprecedented huge. However, the present recovery rate of paper products in China is less than 50%, which is far lower than that of the more developed countries in the world (Chinabaogao, 2017). Unrecoverable paper products are not only a great waste of resources, but their processing and production process causes serious environmental pollution. This waste of resources directly leads to environmental disruption in the upstream industry of the paper industry.

Environment and resources have the property of public goods, which is related to the interests and future development of all mankind, while human development has huge impact on the environment. How to effectively get a balance between the two is a matter of concern. It is not difficult to see that the rise and rapid development of e-commerce has begun to consume a large number of environmental resources, and in such a development trend, huge potential environmental hazards are approaching step by step. Therefore, it is necessary to have a comprehensive and profound understanding of the environmental impact of excessive paper packaging in the field of e-commerce, and to propose feasible solutions for the current situation. It is remarkable that the scope of e-commerce is wide, and there are many kinds of paper packaging utilization involved. First, it is more significant to explore the paper packaging in express delivery industry, which is the most prominent one. Therefore, this paper will mainly expound paper packaging in express industry. In terms of the industry chain, paper packaging in express industry appears in many links, mainly including three stages: 1) the production stage of paper packaging products, that is, from raw materials to finished products; 2) the use of paper packaging products in the process of express and logistics transportation process, that is, the use of paper product packaging by third-party suppliers (e-commerce platform, retailers, individuals, etc.) 3) Paper packaging products reach the end consumers, that is, e-commerce consumers ultimately get the purchased goods and paper packaging products, and do the end-treatment for the paper packaging products. These three stages will produce different environmental impacts, including resource consumption and pollution emissions. Considering the main object of this paper is paper packaging itself, we will focus on the production in first stage and the recycling in third stage. As for the second stage, we will conduct a research and collation in the form of expert interviews because the logistics and warehousing are involved.

1. The Trend of Current Situation of Paper Packaging in E-commerce Consumption

1.1 The Current situation of E-commerce Consumption

1. 1. 1 The International Situation

From the perspective of the global environment, the E-commerce market has maintained comparatively rapid growth for more than a decade, and this growth momentum is still continuing. At present, the number of Internet users in the world has reached 4.16 billion, and that in Asia accounts for half of the total. While developed countries and regions have high Internet coverage, but the growth rate of Internet users is relatively low (CEICC, 2018). According to Internet World Stats data, there are seven countries that have over 100 million netizens in the world, namely China, India, the United States, Brazil, Indonesia, Japan and Russia (Internet World Stats, 2018). Thanks to the bonus of huge net user base, the total volume of retail E-commerce transactions exceeded 2.3 trillion US dollars in 2017, an increase of 21% over the previous year. It is predicted that the total volume of such transaction volume will double in 2021 (Orendorff, 2017). In comparison, the total volume of global retail sales in 2017 was 22.6 trillion US dollars, an increase of 5.8% over the previous year. The proportion of online retail sales in the global retail sales rose from 8.6% in 2016 to 10.2% in 2017. The importance of online retail in social retail activities is increasing year by year (Table 1.1.1-1, Ministry of Commerce of China, 2017). The statistics of Orendorff also show that China is currently the largest E-commerce market ($672 billion), followed by the United States, Britain, Japan, Germany, etc. (2017). However, the growth rate of the global single business market, except for a few emerging markets, has shown a slowing trend, mainly because the growth rate of Internet users is declining and the growth space and potential of the industry are limited.

Table 1.1.1-1: Global Retail and E-commerce Data and Forecasts from 2016 to 2021

Year	total retail sales (Trillion US Dollars)	Growth Rate	Online Retail Sales (Trillion US Dollars)	Growth Rate	Proportion of Online Retail
2021e	27.920	4.90%	4.878	18.00%	17.50%
2020e	26.610	5.30%	4.135	19.80%	15.50%
2019e	25.271	5.50%	3.453	21.50%	13.70%
2018e	23.946	5.80%	2.842	23.30%	11.90%
2017	22.640	5.80%	2.304	24.80%	10.20%
2016	21.396	5.20%	1.845	25.60%	8.60%

The year of figure e is the forecast value

The development of E-commerce in different countries and regions has its own characteristics:

The United States is the country with the earliest and most mature development of E-commerce, and has produced several world-class E-commerce platforms, such as Amazon, Apple and Wal-Mart, as well as the famous "Black Friday" and other online shopping carnival and promotion festivals. Statistics from the United States Bureau of Statistics show that the online retail sales in 2017 were 452.076 billion US dollars, an increase of 15.9% over the previous year, ranking second in the world, with online retail sales accounting for 8.9% of the total social retail sales (Ministry of Commerce of China, 2017). China is the largest and most dynamic E-commerce market in the world. In recent years, the "Double Eleven" has created a miracle of daily turnover. Britain is Europe's largest E-commerce market, with Internet penetration reaching more than 90%, and E-commerce sales exceeding 7% of GDP. Japanese and Korean B2B and B2C E-commerce account for more than half (60%, 80%) of Gross Domestic Product's annual transactions; Latin America is the most popular emerging market for e-commerce. From 2016 onwards, Brazil has become the first e-commerce market in Latin America. Judging from the growth area of online shopping, the Middle East and Africa will be the latest vitality of E-commerce market development in the next few years (CEICC, 2018). Although the development of global E-commerce is slowing down, new formats and new modes driven by new technologies are emerging one after another. As a result, the development of E-commerce is gradually moving from extensive growth to intensive and refined growth.

The achievements of cross-border e-commerce companies have also attracted much attention. With the increase of people's purchasing power, people demand more for the

quality, cost performance, brand and variety of commodities, and the overseas online shopping market is expanding worldwide. According to the research predict of the United Nations Conference on Trade and Development (UNCTAD), the global cross-border e-commerce transaction volume will exceed 670 billion US dollars in 2018 and is expected to exceed trillion US dollars by 2020 (UNCTAD, 2016). From a regional perspective, Europe is the largest cross-border electronic commerce market in the world, while the development of cross-border e-commerce in the United States is relatively lagging behind; more than half of e-commerce transactions in Canada, Mexico and South Korea are concluded with the United States, while more than half of cross-border e-commerce transactions in the United States, Brazil, Russia and Hungary are concluded with China (IPC, 2018); IPC (2018) also found that clothing accounted for the highest proportion (30%) of the top five cross-border purchases, followed by consumer electronics (19%), health products and cosmetics (14%), books and audio-visual products (10%) and jewelry (9%). In 2017, China's cross-border e-commerce continued to maintain a rapid development trend, and cross-border online retail grows rapidly. Customs statistics show that the import and export volume of cross-border e-commerce checked and released by the Chinese Customs in 2017 is 90.24 billion yuan, an increase of 80.6% over the previous year, of which 33.65 billion yuan is exported and 56.59 billion yuan is imported, an increase of 41.3% and 120% respectively. In the past three years, the average annual growth rate of cross-border e-commerce retail imports and exports of China Customs is more than 50%(Ministry of Commerce, 2017). The borderless e-commerce not only directly promotes the integration of online and offline, blurs the industrial boundaries, and creates many borderless enterprises, but also indirectly improves trade equality, provides job opportunities and shares more resources.

1.1.2 The Domestic Current situation in China

In 2017, General Secretary Xi Jinping mentioned the Internet many times in his report of 19th CPC National Congress, which shows the important position of the Internet in economic and social development. In recent years, from the popularization of information technology, to the transformation and upgrading of traditional enterprises assisted by the Internet, then to the deep integration of Internet, big data and artificial intelligence, China has achieved rapid economic development with the help of Internet dividends. The continuous innovation of the Internet mode, the acceleration of the integration of online and offline services, and the acceleration of the pace of online public services have kept China's Internet population growing continuously and steadily.

According to the 41st Statistics Report on the Development of China's Internet released by the China Internet Network Information Center, by December 2017, the number of Internet users in China had reached 772 million, with a penetration rate of 55.8%. The number of mobile phone users reached 753 million, and the proportion of people using mobile phones to surf the Internet rose to 97.5% (CNNIC, 2018).

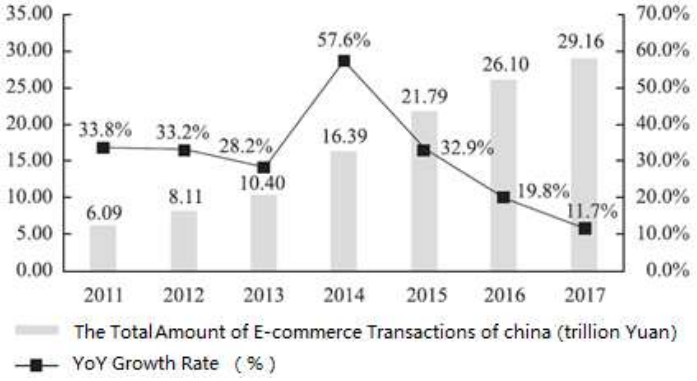


Figure 1.1.2-1: China's Total E-commerce Transactions Volume and Growth Rate from 2011 to 2017

Because of the harmonious Internet environment, continuously developing online payment tools and deeply integrated O2O, the Chinese E-commerce field makes vigorous development. At present, the number of online shopping users in China exceeds 530 million（Including 340 million online takeout users）, and the total amount of E-commerce transactions reached 29.2 trillion Yuan in 2017(CEICC, 2018), increasing 11.7% year-on-year. Although the growth rate has slowed down in recent years, the overall upward trend remains unchanged (Figure 1.1.2-1). And the amount of transactions in the online retail industry alone reached nearly 7.2 trillion Yuan, increasing 32.2% year-on-year (Figure 1.1.2-2) (CNNIC, 2018). The online retail sales of physical commodities amounted to 5.5 trillion Yuan, accounting for 76.3% of the online retail sales, increasing 28.0% from the same period in 2016, and accounting for 15.0% of the total retail sales of social consumer goods (Ministry of Commerce of China, 2017).



Figure 1.1.2-2: The Scale of Online Retail Transactions in China from 2011 to 2017

The innovation of service mode and technological form in the field of E-commerce emerge in endlessly. Not only are there a large number of unattended convenience stores, restaurants, and office shelves, but mobile payments and face brushing payments also make these conveniences normal. For traditional formats, E-commerce also plays an energizing role. For example, the virtual fitting room, which was realized by the AR, has effectively promoted the upgrading of offline entity commerce and increased the transaction volume.

The development of E-commerce is also protected by the formulation and improvement of relevant laws，regulations and the support of national policies. In June 2018, the Electronic Commerce Law draft, which has absorbed a wide range of opinions and included redefining "Electronic Ecommerce Operators" (Covering Wechat business that we are familiar with) was submitted to the Third Review of the NPC Standing Committee of China. It is expected to fill much blank space in the field after the pass of the law (SOHU, 2018). In addition, "Cybersecurity Law of China" and some related Internet information management regulations provide legal protection for network information (Including personal information) and purify the network environment. Furthermore, "the Notice on Promoting the Development of E-commerce" issued by the National Development and Reform Commission will create national E-commerce demonstration cities (Lin, 2017) in 17 cities. It not only greatly promotes the local economy, supports many E-commerce enterprises, logistics enterprises and retailers, but also accumulates valuable experience for the future development of E-commerce.

1.2 Paper Packaging Industry Status

China's modern paper industry has achieved a real start since the reform and opening

up. With the support of national policies and funds, the paper industry has achieved the stride development. After several decades of development, China began to break away from import dependence in 2007 and basically achieved domestic supply balance; Since 2009, China has continuously become the world's largest producer and consumer of paper and cardboard (CHYXX, 2018); In 2017, there were about 2,800 papermaking enterprises above the average scale in China, and the national paper and board production exceeded 110 million tons (the output of the 11 provinces in the east accounted for 74.9%), the consumption and production were basically the same, and the per capita annual consumption was 78 kg (China Paper Association, 2018). In recent years, the state has implemented supply-side reform to eliminate backward production capacity. Under the increasingly stringent environmental pressure, the paper industry, like other traditional manufacturing industries, has been impacted to a certain extent. However, with the improvement of standardization and concentration of the industry and the vigorous development of downstream industries such as e-commerce, the paper industry has maintained a relatively stable growth trend, and even slightly supply falls behind demand in the field of packaging paper.

Packaging paper occupies the absolute leading position among numerous applications of paper products in the industry. The production of packaging paper is mostly based on waste paper and its secondary utilization products mainly include white board, box board and corrugated base paper. White board is a kind of cardboard made by machine with white paint coating on one-sided. After one-sided color printing, it is usually used to make packing boxes. Box board is also called kraft paper or kraft cardboard, which is mainly used to bond corrugated base paper to make corrugated board. Corrugated base paper, also known as corrugating medium, is corrugated core in the middle layer of corrugated board. Because its structure has anti-seismic effect, corrugated cartons are often used as the outer packing of downstream products. According to 2017 Annual Report of China's Paper Industry, the total production and consumption of packaging paper in 2017 were 68.45 million tons and 69.72 million tons respectively, accounting for 61.4% and 63.4% of the total paper industry. Among them, cardboard paper and corrugated base paper constitute the main elements of paper packaging production and consumption, and their production and consumption remain basically the same level, both accounting for about 70% of the total packaging paper; white board production was 14.3 million tons in 2017, slightly higher than its consumption of 12.99 million tons (China Paper Association, 2018). For more relevant data, please refer to Table 1.2-1:

Table 1.2-1: Total Production and Total Consumption of All Types of Packaging Paper

As the main raw material for packaging paper, waste paper mainly comes from domestic recycling and foreign import. According to the Report on Operation Status and Development Prospects of Waste Paper Recycling Industry in China from 2017 to 2022, China's annual recycling of waste paper has reached 50 million tons in recent

Types	Production 2017 (Mt)	Y-O-Y Growth (%)	Consumption 2017 (Mt)	Y-O-Y Growth (%)	Import volume 2017 (Mt)	Export volume 2017 (Mt)
Total Paper for Packaging	68.45	2.85	69.12	4.90	2.78	2.2
White board	14.3	1.78	12.99	2.69	0.62	1.93
Box board	23.85	3.47	25.1	6.18	1.37	0.12
Corrugated base paper	23.35	2.86	23.96	5.50	0.65	0.04
Other wrapping paper	6.95	2.96	7.07	2.61	0.23	0.11

years, which occupied the first in Asia and other countries in the world (Chinabaogao, 2017). But it is greatly benefited from China's population base, while the actual recovery rate still lags behind the more developed countries. According to the calculation formula given in the above report:

$$\text{Waste paper recovery rate} = \frac{\text{Domestic Recycling of Waste Paper (Purchase of Waste Paper in Paper Mill + Export of Waste Paper − Import of Waste Paper)}}{\text{Domestic consumption of paper and cardboard (paper and cardboard sales in paper mills − paper and cardboard exports + paper and cardboard imports)}}$$

the recycling rate of waste paper in China has been less than 50 per cent up to now, well below that in Korea (90 per cent), France(82 per cent) and Japan(79 per cent), the top three countries in the world (Chinabaogao, 2017). Chinese paper industry started to restructure after the "12th Five-Year Plan". The number of new projects using waste paper as raw materials has risen and the scale has increased, so that the recycling efficiency of waste paper also has improved. At present, the recycling efficiency of waste paper in our country has increased to close to Finland and Sweden, and the recycling efficiency of waste paper has reached a high level in the world (72 %) (Bojianbook, 2017). According to the import situation of waste paper, the main suppliers of waste paper in China are the United States, the United Kingdom, and Japan, among which the United States is the largest supplier, accounting for more than 40% of the total (CHYXX, 2018). However, on August 10, 2017, the Ministry of Environmental Protection, the Development and Reform Commission and the General Administration of Customs jointly revised the Catalogue of Import Waste Management

to include unsorted waste paper in the Catalogue of Prohibited Import of Solid Waste, resulting in a tight market supply of imported waste paper. This forces our country to accelerate the development of domestic waste paper recycling potential so as to balance the growing demand.

Overall, the development prospects of paper packaging industry are promising, mainly in the following aspects: first, paper packaging is widely used. The world paper packaging industry output value accounts for more than 30% of all packaging, while China's paper and cardboard consumption is only one tenth of that of developed countries, which shows that there is a huge space for the development of paper packaging industry in China; Second, the performance design and decoration design of paper packaging products are highly valued throughout the industry. Various new processes and technologies, such as corrugated line technology, carton pre-printing technology and corrugated paper digital printing technology, continue to refresh, which will bring more choices for the paper packaging industry. Third, the policy-oriented benefits to large-scale paper enterprises, frequent industry mergers and acquisitions are all conducive to further optimization of the industrial structure. Fourth, compared with other packaging categories, paper packaging is a sustainable "green packaging" with low relative cost, resource saving and easy recycling. Besides, it has more development prospects (Zhang, 2017).

1.3 Paper Packaging Industry Chain and Stakeholders in E-commerce Consumption

The whole life cycle of paper packaging goes through the circulation from raw materials to pulp and finally recycled waste paper into recycled paper. The whole industrial chain can be roughly divided into three main stages: production and processing of paper packaging, circulation in e-commerce, and waste paper recycling (Fig. 1.3-1).

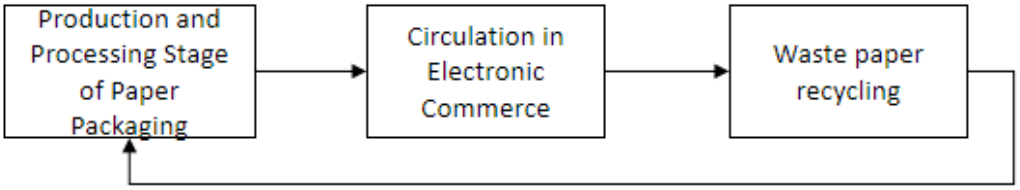


Figure 1.3-1: The Lifecycle of Paper Packaging

1.3.1 Production and Processing Stage of Paper Packaging

The industry chain of paper packaging production and processing is relatively short, mainly including pulp manufacturing industry, paper-making industry, and paper products manufacturing industry (Chinabaogao, 2018), as shown in Figure 1.3.1-1. There are various types of papermaking enterprises in China, such as An Hui Shan Ying Paer Industry CO. Ltd, Shan Dong Sun Paper Industry Joint Stock Co.Ltd., and Shandong Chenming Paper Holdings Ltd., which have relatively complete industrial chain, while Jingxing Paper and Xiamen Hexing Packaging Printing Co. Ltd. main for the manufacture of paper products. In addition to the main industrial chain of paper products production and processing, there are many other interrelated industries, such as additive manufacturers for pulp manufacturing and paper making, equipment suppliers for the whole industry chain, design and printing industries that service for paper products manufacturing, environmental protection industries that deal with the pollution caused by three wastes of paper making, and traders who export paper products. The following will introduce the current situation of the main industry chains of paper packaging separately.

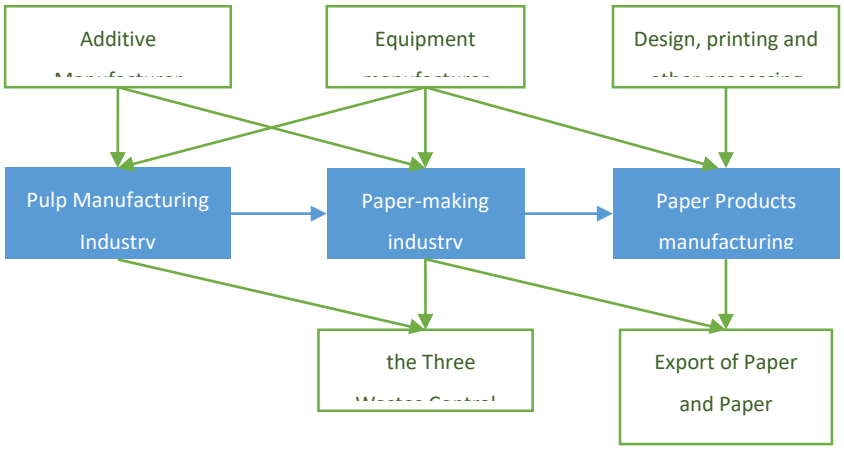


Figure 1.3.1-1: The Industry Chain of Paper Packaging Production and Processing

Pulp Manufacturing Industry

In the pulp manufacturing industry, the pulp produced can be divided into three main categories: wood pulp, waste pulp, and non-wood pulp (including reed pulp, bamboo pulp, rice straw pulp, and other pulps). Among them, wood pulp is mainly used to process white cardboard in packaging paper, while corrugated paper, box board paper and white board paper are mainly processed from waste paper pulp. The pulp consumed annually in China comes from domestic pulp production, imported wood pulp and imported waste paper pulping. According to *2017 Annual Report of China's Paper Industry*, from perspective of the production situation, China's pulp output in 2017 is 103 million tons, of which 10.5 million tons are produced from domestic wood pulp, 63.2 million tons from waste paper pulp and 23.73 million tons from imported waste paper. From the perspective of the consumption situation, China consumed 101 million tons of pulp, 10.4 million tons of domestic wood pulp, 63.2 million tons of waste pulp and 21.12 million tons of imported waste paper pulp in 2017 (China Paper Association, 2018).China's annual output of pulp is less than 1/1000 of the annual output.

At present, China's policy on importing foreign garbage (foreign waste) is becoming stricter. From a historical point of view, the proportion of waste paper used in China accounts for 2/3 of the total amount of waste paper used in China and 1/3 in imported waste paper (of which the proportion of waste paper used in the United States accounts for half of the total amount of imports) (Shi and Ma, 2018). However, starting from 2017, China has successively introduced policies on restricting imported waste paper. See table below (Shi and Ma, 2018):

Table 1.3.1-1: A List of China's Policy on Restricting the Import of Waste Paper

Time	Policy	Department	Relevant Content
2017.04	"Implementation Plan for the Reform of the Import Management System for the Prohibition of Foreign Waste Entry into the Solid Waste"	General Office of the State Council	Adjust the import waste management catalogue, prohibit the import of waste plastics from domestic sources, unsorted waste paper, waste textile raw materials, vanadium slag and other solid waste, and officially implement at the end of 2017.
2017.07			China officially issued a notice to the World Trade Organization (WTO), saying that it will stop receiving waste plastics, paper, waste slag, textiles and other foreign wastes by the end of 2017.
2017.08	Catalogue of Import Waste Management (2017)	Ministry of Environmental Protection, Ministry of Commerce, Development and Reform Commission, General Administration of Customs and General Administration of Quality Supervision and Inspection	Four types of 24 solid wastes were listed into the Catalogue of Solid Wastes Prohibiting Import from the Catalogue of Solid Wastes Restricting Import Catalogue as Raw Materials, including unsorted waste paper (1 variety) and waste textile raw materials (11 varieties)
2017.12	Regulations on Environmental Protection Management of Imported Waste Paper	Ministry of Environmental Protection	The scale of imported waste paper processing and utilization enterprises is not less than 50,000 tons per year, and the processing and utilization sites, equipment, pollution prevention facilities and measures related to environmental protection management of imported waste paper processing and utilization enterprises are clearly required.
2017.12	Standards for Environmental Protection Control of Imported Solid Wastes Used as Raw Materials	Ministry of Environmental Protection	The impurity content of waste paper has been reduced from 1.5% to 0.5%. It will implement on March 1.
2018.05	Notice of the General	General	1) Implement 100% open-box and out-of-box

	Administration of Customs on Implementing Risk Early Warning and Supervision Measures for Importing Waste Raw Materials from the United States	Administration of Customs	inspection and Quarantine of waste materials from the United States; 2) Since May 4, China Inspection and Certification Group North America Limited has implemented Class A risk early warning measures for one month, during which the company will no longer undertake pre-shipment inspection of imported waste materials; 3) Strengthen document audit.

The introduction of relevant restriction policies has limited the supply of raw materials to a certain extent and has had a certain impact on the domestic paper industry. On the one hand, the shortage of raw materials and the tightening of environmental protection policies have caused the price of domestic finished paper to rise and the quantity of imported finished paper to rise. The price of imported finished paper acts as the price ceiling, limiting the price fluctuation of domestic finished paper. On the other hand, according to Zheng et al., if the import volume of waste paper falls by 10% in 2018 compared with 2017, the recovery rate of domestic packing paper needs to be increased to 80%, if it falls by 20%, the domestic recovery rate needs to be increased to 83%, approaching the recovery limitation of waste paper (Zheng et al., 2018).This puts forward quite high requirements for the domestic waste paper recycling and processing industry and also brings opportunities. Finally, imported waste paper's tightening and the relevant policies of supply-side structural reform have greatly benefited some leading papermaking enterprises. The closure of backward productivity, the concentration of import quotas from large enterprises, and the acquisition of raw materials from overseas mergers and acquisitions have all further enhanced the industrial concentration and optimized the industrial pattern.

Paper-making Industry

Driven by the supply-side reform, the domestic papermaking industry has achieved remarkable results in reducing capacity, the supply and demand pattern has been further improved, and papermaking enterprises have shown the Matthew Effect. In the early extensive development mode, the number of small and medium-sized enterprises in the paper industry accounts for a large proportion. Because the industry-driven and the technical level and production methods are not standardized, the supply exceeds demand and pollution is serious. In 2011, the Ministry of Industry and Information Technology and the Forestry Bureau jointly issued the “12th Five-Year Plan for Paper Industry Development” and began to implement the supply-side reform of the paper industry. According to the research of Everbright Securities, during the 12th Five-Year

Plan period, the industry eliminated a total of 38.72 million tons of backward production capacity, which accounted for 30% of the annual production in 2016, and will continue to phase out 8 million tons of backward production capacity during the 13th Five-Year Plan period(Li, 2018). Li (2018)'s research also shows that the fixed asset investment in the paper industry has gradually declined in recent years. Under the dual effects of production capacity clearing and new investment slowdown, the paper industry has seen a significant contraction and the industry pattern has gradually improved.

The improvement of the environmental protection system is a sword to eliminate backward production capacity, laying a foundation for the stable development of the paper industry. The relevant environmental protection system measures are detailed in the following table (Table 1.3.1-2):

Table 1.3.1-2: A list of Environmental Protection Policies of Paper Manufacturing Industry in China

Time	Policy	Department	Relevant Content
2016-	Environmental Supervision	Ministry of Environmental Protection, Central Commission for Discipline Inspection, Central Organization Department	Establish and implement environmental inspection mechanisms in all provinces and cities across the country and conduct environmental supervision on production in the papermaking, printing, packaging and other industries.
2016.12	Environmental Protection Tax Law	Ministry of Environmental Protection, Ministry of Finance, State Administration of Taxation	Starting from January 1, 2018, the environmental protection tax will be charged instead of the sewage charge, and the equivalent tax amount will be imposed on the waste water and pollutants.
2017.01	Interim Provisions on the Administration of Pollution Discharge Permits	Ministry of Environmental Protection	The state unifies the national management of pollutant discharge permits and adopts the "total amount control system" to control the annual pollutant discharge value.
2017.01	Notice on the Management of Elevated Source	Ministry of Environmental Protection	From July 1, 2017, papermaking enterprises shall establish a system of self-monitoring, information disclosure, record-keeping and

	Pollution Discharge License in Thermal Power, Paper Industry and Pilot Cities of Beijing, Tianjin and Hebei		periodic reporting.
2018.03	Specific Control Scheme for Standardized Construction and Operation of Coal-fired Self-contained Power Plants	National Development and Reform Commission	Strictly control new coal-fired self-owned power plants, thoroughly clean up illegal coal-fired self-owned power plants, strictly complete environmental protection renovation within the prescribed time limit, resolutely eliminate backward capacity of coal-fired self-owned power plants, etc.

From environmental supervision and environmental protection, to the tighting of the emission permit system, and to the energy side reformin the paper industry... the superposition of multiple factors has increased the cost pressure of small and medium-sized enterprises with insufficient technological innovation capability and risk control capability and further cleared backward capacity, while the business advantage further tends to the leading enterprises in the industry. According to statistics, in 2017, more than 30% of the production of cardboard paper was concentrated in Shanying Paper, Jingxing Paper, Sun Paper, and Lee & Man Paper. One-fifth of the production of corrugated paper originated from Nine Dragons Paper and Gold. Phoenix Paper, Rongcheng Paper, Liansheng Paper, and Asia Pulp and Paper, Wan Guo Sun, Guangxi Jingui, and Zhanjiang Chenming contributed nearly 60% of white cardboard production capacity (Li, 2018).In addition to the operational advantages brought by the policy for the leading paper enterprises, the development strategy of the enterprises themselves has also further enhanced their competitive advantages. On the one hand, according to the data of Oriental Fortune Choice financial terminal, 92 mergers and acquisitions related to 30 listed papermaking enterprises have occurred since January 1, 2017, reflecting the rapid industrial convergence; on the other hand, many domestic papermaking enterprises have expanded overseas, such as exploring the advantages of abundant forest resources and cheap labor in Southeast Asia, and quickly completing the industrial strategy distribution(Zheng et al., 2018). It shows that the reform of the whole paper industry does not restrict the leading enterprises but clears the obstacles for their long-term development.

Paper Products Manufacturing Industry

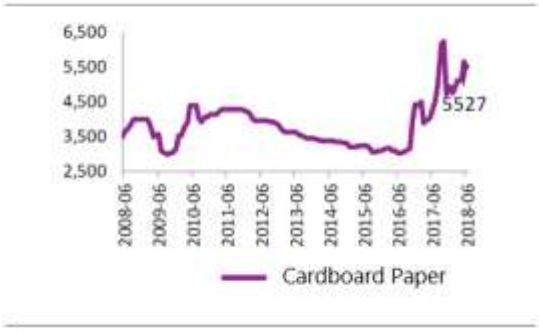
From the perspective of the whole packaging industry, the types of packaging include bamboo and wood packaging, metal packaging, paper packaging, plastic packaging, glass packaging, and other categories. Among them, paper packaging is generally regarded as a green packaging product because of its advantages in energy saving, resource saving and environmental friendliness, etc. In recent years, it has also been more and more popular. According to the statistics of China Industrial Information Network, the global paper packaging market accounts for about 40% of all packaging categories (CHYXX, 2017), which is the largest market share among several packaging categories. It can be predicted that the global paper packaging market will exceed $330 billion in 2018, but the growth rate will slow down to less than 4.0% annually (ASKCI, 2017). China's packaging market has developed rapidly and has become the second largest packaging country after the United States. Paper products market growth is stable, and it is expected to maintain a growth rate of 5-6% in the next few years. It will become the largest producer by 2020 (CHYXX, 2017). However, with the macro-growth trend, the domestic paper packaging industry pattern is changing imperceptibly, which is mainly reflected in the following aspects.

From the perspective of the supplier, the short-term impact of China's policy factors deviates from the economic law. On the one hand, the import restriction of foreign wastes and the insufficient supply of domestic raw materials have greatly increased the cost of raw materials for papermaking, and the cost of raw materials is transmitted downstream; on the other hand, because of the low entry threshold of paper packaging and printing industry, the number of small and medium-sized enterprises in China accounts for more than 90% of the total number of packaging enterprises, and affected by environmental protection policies, the market share gradually flows to enterprises above average scale. The price of upstream raw materials, combined with the shrinking number of enterprises in the industry result in a rapid rise of the paper packaging products' price (Figure 1.3.1-2). According to statistics from Sublime China Information Co., Ltd(SCI), the prices of boxboard and corrugated paper reached their peak in the last decade in the second half of 2017 (Li, 2018). However, the soaring prices did not lead to Large-scale production reduction.

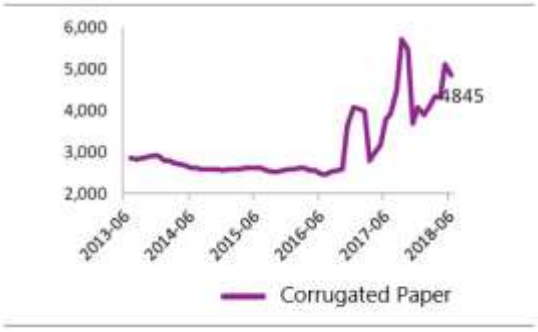
From the perspective of the demand, the growth of downstream industries has driven the paper packaging manufacturing industry and covered the shrinking of industries caused by policy factors. The downstream industries of paper packaging mainly include logistics, daily chemical products, food and beverage, home appliances, consumer

electronics and so on. Stimulated by the booming e-commerce, the downstream industries have maintained relatively stable growth in recent years, of which the logistics industry has maintained an average annual growth rate of more than 50% (Table 1.3.1-3) (Li, 2018). The cost of paper packaging is smoothly transmitted downstream to the next level.

It can be seen that the superimposed intervention of relevant policies does not have a profound impact on the balance of supply and demand, while the improvement of industrial concentration, technological innovation, and the optimization of the industry pattern ensure the stable development of China's paper packaging industry.



Average Market Price of Boxboard Paper (RMB/T)



Average Market Price of Corrugated Paper (RMB/T)

Figure 1.3.1-2: Average Market Price of Boxboard Paper and Corrugated Paper

Table 1.3.1-3: Growth Volume of Paper Packaging Downstream Industry from 2012 to 2016

Growth Rate	Logistics	Daily Chemical Products	Food and Beverage	Home Appliances	Consumer Electronics	Medicine
2012	54.79%	21.57%	13.73%	-1.50%	4.72%	9.79%
2013	61.58%	18.77%	12.78%	18.87%	22.29%	0.22%
2014	51.96%	11.23%	5.30%	11.74%	12.99%	14.95%
2015	48.07%	10.89%	3.21%	6.01%	0.64%	-2.27%
2016	51.33%	11.58%	5.12%	6.23%	19.26%	5.63%
Compound Growth Rate	40.63%	10.32%	3.78%	8.38%	10.64%	3.53%

1. 3. 2 Circulation in Electronic Commerce

The circulation of paper packaging roughly includes two links from the packaged product factory, through the distribution channel, to the consumer (including the end and non-end users) (Figure1.3.2-1). Traditional distribution channels include wholesalers, agents, retailers, trading companies, etc., while the new distribution channels are faster and more convenient because of innovative network technologies and e-commerce platforms that link to producers and consumers more efficiently. E-commerce, as one of the emerging distribution tools, has diverse types according to the different nature of consumers (including B2B, B2C, M2C, O2O, etc.). In the process of paper product packaging, B2B and B2C and B2B are mainly used. B2B here mainly refers to paper packaging reach non-end users (large/small enterprises, small e-commerce) via e-commerce channels, such as downstream product manufacturing (food and beverage, daily chemical products, etc.), paper packaging retailers (moving companies or Packaging stores), or logistics companies, packaged products or paper-packaged products eventually reach end users (individual consumers); B2C refers to the process by which end users obtain paper packaging directly through distribution channels. The end user here refers to the individual consumer of the paper package before being recycled or discarded, while the non-end user refers to the consumer who is in the other process of circulation before reaching the end user.

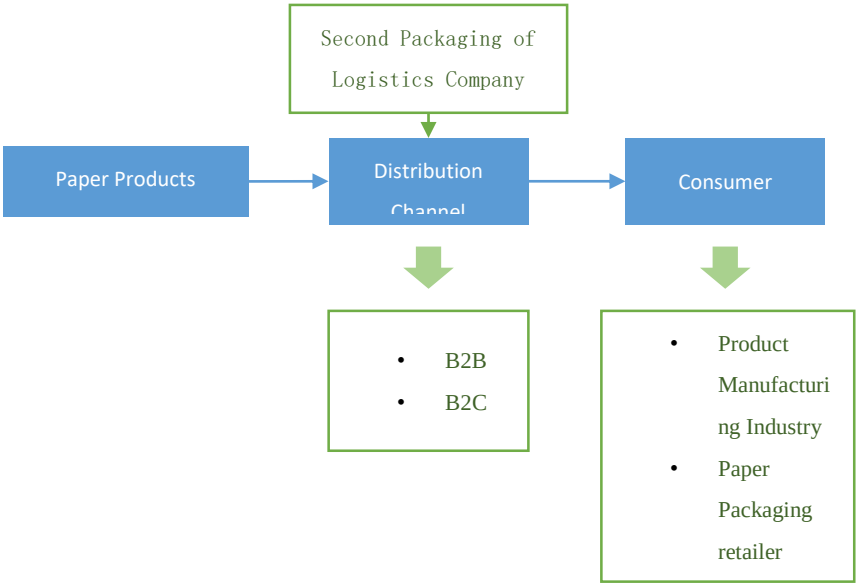


Figure 1.3.2-1: Industrial Chain of Paper Packaging in the Circulation Stage of E-Commerce

Distribution Channel

At present, there are nearly 1,500 B2B e-commerce companies in China. China's rapid development of B2B e-commerce in recent years has benefited from several factors. First, China's GDP (Gross Domestic Product) increased by 6.7% in 2017, which is stable in a reasonable range. In recent years, the CPI (Consumer Price Index) has been stable, while the PPI (Producer Price Index) has increased rapidly (National Bureau of Statistics). The domestic economic recovery has laid a solid foundation for the development of e-commerce. Secondly, the popularity of enterprise informatization has paved the way for the promotion of e-commerce B2B. The Internet and computer usage rate of SMEs in China has exceeded 95%. Although the proportion of online transactions is not too high, the transformation possibility of future enterprise Internet is serious (YIGUAN, 2017).Finally, technological innovations in big data, cloud computing, payment systems, the Internet of Things, and mobile terminals have greatly expanded the business channels of B2B e-commerce, improved its operational efficiency, and provided good and convenient services in transactions. According to statistics from the E-Commerce Research Center, in 2017, China's B2B e-commerce market transaction volume reached 20.5 trillion yuan, an increase of 22.8%; while the B2B e-commerce market revenue reached 35 billion yuan, an increase of 34.6% (Zhang, 2018).

With the development of B2B, China has also formed a complete and stable e-commerce ecosystem, including purchasers and suppliers, as well as online payment services (Citibank, Alipay, etc.), logistics services (SF Express, Yunniao Express, etc.), certification services (China Electronics Business Certification Center and China Information Security Certification Center), media promotion (Baidu, 2B.cn, etc.), and other derivative services (data and consulting, marketing and training, etc.). B2B e-commerce service platform is also divided into integrated e-commerce platform (Alibaba, Marco Polo, etc.) and sub-sector vertical e-commerce platform (Mianzhuang. com, Zhaogang. com, etc.).

In the field of B2B e-commerce, as mentioned above, the transaction volume of China's online retail industry reached nearly 7.2 trillion yuan in 2017, an increase of 32.2% year-on-year (CNNIC, 2018). Although the annual growth rate has gradually slowed down to around 30% (Figure 1.1.1-2), it still maintains a high growth rate, indicating that the domestic B2C field has gradually entered a mature development period. Analysys (2017) conducted an external macro-environmental analysis (PEST analysis) on the B2C e-commerce industry. The analysis shows that the Chinese market is still

relatively benefit from the development of the B2C field in terms of the political environment, social environment, economic environment, and technical environment (Analysys, 2017). Some analysts also said that China has already been in the post-interest dividend era of e-commerce, but the growth potential of overseas B2C e-commerce market has begun to gradually release (CHYXX, 2017).

The market model of B2C in China's retail market is mainly divided into three categories: one is the behavior of retailers to establish a network platform to uniformly purchase, display, trade, and distribute the products they operate to the final consumer groups, such as Jingdong and Vipshop. There are also types of businesses that provide online trading platforms for retailers and provide transaction support, such as Tmall and Taobao; and online platforms built by manufacturers to sell their own products, such as LeTV Mall and Xiaomi Mall (Analysys,2017). Similar to B2B e-commerce, the e-commerce service ecosystem has also been formed in the B2C field, realizing the network retail platform as the center, manufacturers, distributors, logistics, online payment, technical to support, thirdpartnars, shopping consulting and many other fields. But not only that, the emerging elements of the web star economy also injected fresh blood into the industry.

Generally speaking, China's e-commerce (B2B and B2C) field has entered a deep and mature stage of development. From the initial construction of integrated network platform to the rise of vertical e-commerce, and to the current integration of related sub-sectors, a complete e-commerce ecosystem has been built, which can meet the growing needs of the domestic market and play a very important role in promoting the development of global e-commerce. Of course, the healthy development of industry cannot be separated from the support and constraints of policies and regulations. For example, the problem of excessive paper packaging discussed in this paper requires relevant government departments, industry enterprises and consumers to explore a more "green" sustainable development program.

Express and Logistics

In the context of increasing online retail sales in the past seven years (Figure. 13.2-2), only in 2017, China's express business volume reached 40.6 billion pieces, an increase of 28% over the same period of the previous year, accounting for more than 40% of the world's share, ranking first in the world for four consecutive years. Express business increased by 8.78 billion pieces, contributing more than 50% to global express growth. Among them, 9.27 billion units were completed in the same city, an increase of 25%

over the same period of last year; 29.96 billion units were completed in different places, an increase of 28.9% over the same period of last year; 830 million units were completed in international/Hong Kong, Macao and Taiwan, an increase of 33.8% over the same period of last year; and the growth of foreign businesses leads to a significant increase in carbon emissions (State Post Office, 2017). From 2011 to 2017, China's express business has developed rapidly, and its growth rate has an irresistible trend (Figure 1.3.2-2).

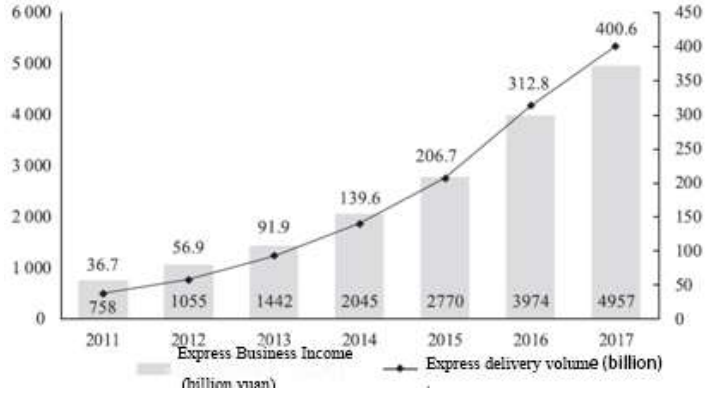


Figure 1.3.2-2: Development of Express Service in China from 2011 to 2017

The size of kraft cardboard boxes provided by the State Post and Telecommunications Bureau has twelve specifications, and corresponding guidance suggestions are made for the packaged goods (as shown in Table 1.3.2-1, Table 1.3.2-2 and Table 1.3.2-3 are the specifications of cartons provided by SF Express and Debang Express respectively, only for reference).Fixed specifications of cartons to a large extent save transportation space and reduce goods in transport shaking or collision. In this way, it not only effectively saves transportation costs, but also reduces customer complaints caused by damage of goods. In fact, especially in the field of e-commerce, customer satisfaction is particularly valued by businesses. In order to avoid the damage of goods in the transport process, businesses also need a certain amount of filling materials wrapped around the goods as a buffer expect choosing the appropriate size of the packaging box. The use of excessive packaging and filling materials has much to do with the "rough handling" chaos in the transport industry, although in many cases commodities (such as towels, chopsticks and other daily necessities) are not easily damaged. In addition, warehousing problems have also been recognized by some consumers as one of the causes of excessive packaging. When a consumer purchases multiple items from the same merchant or different merchants online, the goods themselves may be stored in different warehouses in the city or in different cities. One online transaction may generate multiple packages and multi-line transportation, and as the transaction itself,

the total amount of goods may only occupy a small volume. Since the cost of packaging materials is often directly transmitted to the end user, the logistics industry may aggravate the over-packaging problem under certain circumstances, which is inconsistent with the original design intention of saving transportation space and reducing transportation costs.

Table 1.3.2-1: Standard Postal Carton Specifications and Main Packing Contents

No.	Length(mm) ×Width(mm) ×Height(mm)	Main Packing Contents
1	530 ×290 ×370	Household appliances
2	530 ×230 ×290	Large and small household appliances
3	430 ×210 ×270	Sundries, large bags, heavy clothes, etc.
4	350 ×190 ×230	Boots, medium-sized bags, pillows, etc.
5	290 ×170 ×190	Shoes, small clothes, magazines, books, etc.
6	260 ×150 ×180	Snacks, milk powder, facial mask, etc.
7	230 ×130 ×160	Cosmetics, cups, quilts, tapes, etc.
8	210 ×110 ×140	Moisturizing water, facial mask, CD, etc.
9	195 ×105 ×135	Draw paper, wash milk, mask, etc.
10	175 ×95 ×115	Stationery supplies, paper towels, towels, wet towels, etc.
11	145 ×85 ×105	Perfume, soap, cell phone, etc.
12	130 ×80 ×90	Mouse, cream, cosmetics, some small accessories, etc.

Table 1.3.2-2: Six Standard Cartons in Shunfeng Express Packaging

No.	Length(mm) ×Width(mm) ×Height(mm)	Maximum Load Capacity
1	200 ×180 ×100	1.5 kg
2	250 ×200 ×180	3 kg
3	300 ×250 ×200	5 kg
4	360 ×300 ×250	10 kg
5	530 ×320 ×230	15 kg
6	700 ×400 ×320	15 kg

Table 1.3.2-3: Packing Specification and Charge Standard of Debon Express Carton

No.	Length(mm)×Width(mm) ×Height(mm)	Price
No. 1	600×500×400	15 yuan / carton
No. 2	500×320×540	10 yuan / carton

No. 3	460×280×330	7 yuan / carton
No. 4	300×230×230	5 yuan / carton
Express Small Box	200×180×100	1 yuan / carton
Express No. 1	250×200×180	2 yuan / carton
Express No. 2	300×250×200	3 yuan / carton
Express No. 3	360×300×250	4 yuan / carton
Express No. 4	530×320×230	5 yuan / carton

In 2016, the total amount of cartons used in the domestic express delivery industry was about 8.6 billion, of which the number of cartons used directly by the express delivery industry was about 3.7 billion, accounting for 43%. The remaining 57% cartons are self-contained by e-commerce platforms and sellers. Among them there is no lack of express delivery and logistics industry to make secondary packaging in the case of packaging of products. However, it is gratifying that compared with the data in 2015, the overall usage of the national express delivery cartons in 2016 has been a negative growth, with a reduction of about 13.32% on the premise of the piece that the business volume has increased by 10 billion(China Post Express, 2017). It is then a strong evidence to show that the express packaging standardization and greening process has been significantly improved.

Consumer

With the transformation of retail industry from traditional mode to online mode, then to the new mode of combining online consumption with offline experience, consumer behavior habits have also changed. According to McKinsey's interview with more than 5,900 Chinese consumers, in terms of consumer preferences, online and offline shopping has become the mainstream mode of consumption. When buying electronic products，93% of respondents will pick online and then go to stores to experience. The development of social media promotes the interaction between e-commerce and consumers. McKinsey's research shows that social media has increased 10% of users' shopping time (Wang et al., 2017). Although the development of e-commerce has promoted the change of consumers' shopping habits to a certain extent, there are still many problems in online shopping from the perspective of consumers' interests, including commodity damage caused by "rough handling" chaos in the logistics industry.

According to the statistics from E-Commerce Research Center, retail e-commerce complaints accounted for the highest proportion, for 60.59% of all e-commerce

complaints in 2017, a year on year increase of 7.91%. Hot issues of complaints include delivery, commodity quality, suspected counterfeiting, logistic and so on. The top 10 complaints of logistics enterprises are: Haidaibao 22.50%, Shifang 15.63%, Fast Bird 7.50%, Tiantian Express 6.88%, Baishi Express 6.88%, Tianma Express 4.38%, Shentong Express 4.38%, Shunfeng Express 3.75%, Yunda Express 3.14%, Baitong Logistics 3.13%. Complaints mainly include difficulty in obtaining compensation of loss or damaged, slow transit speed, unreasonable charges, poor customer service and so on (CIECC, 2018).The China Consumers Association's survey report on 10 large express delivery companies in China showed that 46.8% of the express delivery items were packaged on the basis of the original packaging, and 7.9% of the outer packaging were damaged, 16.1% of the internal items were damaged (China Consumers Association, 2017). In the investigation of express branch office, there are "violent" sorting in nearly half of the offices: although most of the staffs are paying attention to avoid pulling and drag the goods (78.6%), treading or sitting on the courier (91.7%), most of them can be cautious about items with fragile signs (76.6%), but throwing or kicks (50.0%) on items and throwing goods directly onto the ground from high places (38.0%) always exist while moving (China Consumers Association, 2017). From this point of view, over-packaging seems to be an effective means of reasonable settlement of disputes and complaints to ensure the safety and integrity of goods whether from the perspective of the interests of consumers, online retailers, or logistics companies. However, this has made it quite difficult to recycle the downstream paper products.

1.3.3 Waste paper recycling and reuse stage

The resolution of packaging waste in China can be roughly divided into two situations: one is recycled by recyclers to the next level of application, such as pulp production, furniture board production, soil improver production, and the other is as solid waste, into solid waste treatment system (Figure 1.3.3-1).

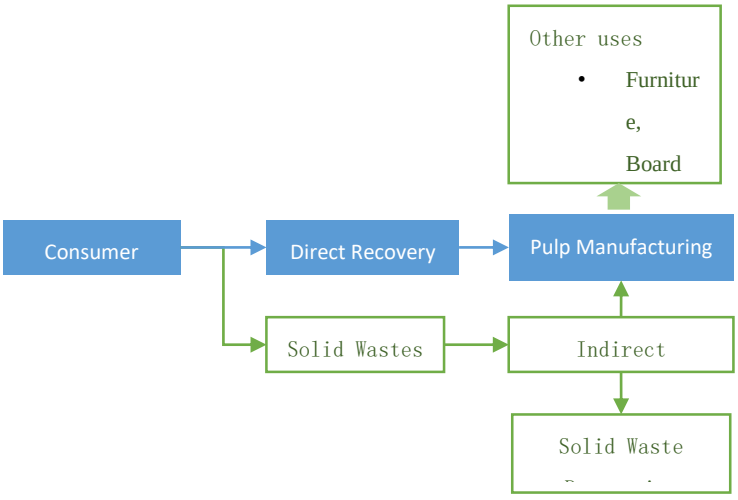


Figure 1.3.3-1: Industrial Chain of Paper Packaging Recycling and Reuse Stage

Zhou et al. (2010) studied the recycling situation of packaging wastes in China, and summarized the circulation of paper packaging wastes into four situations: first, a few of them, mainly small packaging paper with no recycling value were mixed into municipal domestic wastes; second, some of them entered into villages without recycling conditions; third, some of them were recycled directly after residents' consumption; fourth, most of them were directly recycled from producers or after consumption in circulation area (Figure 1.3.3-2).

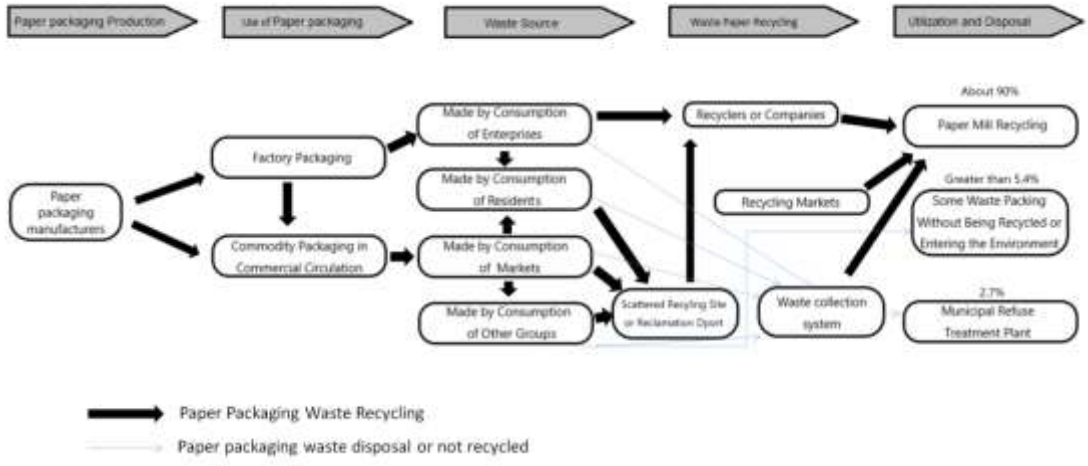


Figure 1.3.3-2: Production and Whereabouts of Paper Packaging Waste

From the current situation of recycling, waste newspapers, books and commodity packages of urban residents in China are usually sold to nearby recycling outlets after they are used. In addition to the backward and remote areas with underdeveloped transportation, there are spontaneously established waste paper or waste material recycling outlets in all communities, streets and villages of large and medium-sized

cities throughout the country. Factories and supermarkets do not regard waste packaging as garbage. Generally, they sold waste packaging to waste paper recycling outlets to sort and pack through bidding. Basically, no one in cities above the county level in China has discarded waste paper or paper packaging in batches (even if someone does, the paper packing will be soon picked up and sold by others).There are few of discarded waste paper or paper packaging on the street let alone in trash cans.

From the perspective of the clearance situation, the recycling of waste paper in China is gradually trying a packaging logistics transportation system from transported in bulk. From the beginning of the pilot introduction of balers, to digestion and absorption of self-designed, production of balers， the production and utilization level of waste paper baler in China now is basically in line with that of foreign countries. After using the baler to further sorted and packed the recycled waste paper at the baling station, the transport radius of waste paper has expanded, which increases the purchasing quantity of waste paper in paper mills, strengthens the quality control of waste paper in paper mills, and effectively promotes the overall improvement of the recycling quality of waste paper. At the same time, the packaged waste paper sorted and packed at the packing station is entrusted to the logistics company for transportation or brought back to the paper mill by empty trucks after paper feeding from the paper mill. The transportation radius of the waste paper is greatly expanding and the transportation speed is faster (Zhang and Liu, 2012).

China's waste paper recycling rate has grown steadily, but it is still at a low level in the world. The recycling rate of waste paper increased from 30.4% in 2004 to 48.1% in 2014 (Figure 1.3.3-3) (Chinabaogao, 2017), reaching the best level in history. The recycling rate of waste paper is 47.6%in 2016, 0.9% higher than 2015 (Guo, 2017). In 2017, 65.8% of the paper consumed in the United States was recycled. Compared with the record of 67.2% in 2016, the recycling rate of waste paper decreased slightly (Chen, 2018). The recycling rate of waste paper in Europe reached 71.5% in 2015, which is higher than the target of 70% set by the European Waste Paper Recycling Committee in the third European Waste Paper Recycling Program (Wu, 2016). From a global perspective, China's waste paper recycling rate is still significantly lower than the world's leading level. Among the top ten major paper-making countries in the world in 2014, the recycling rate of waste paper in Korea was as high as 88%, ranking first in the world (Fig. 1.3.3-4) (Chinabaogao, 2017).

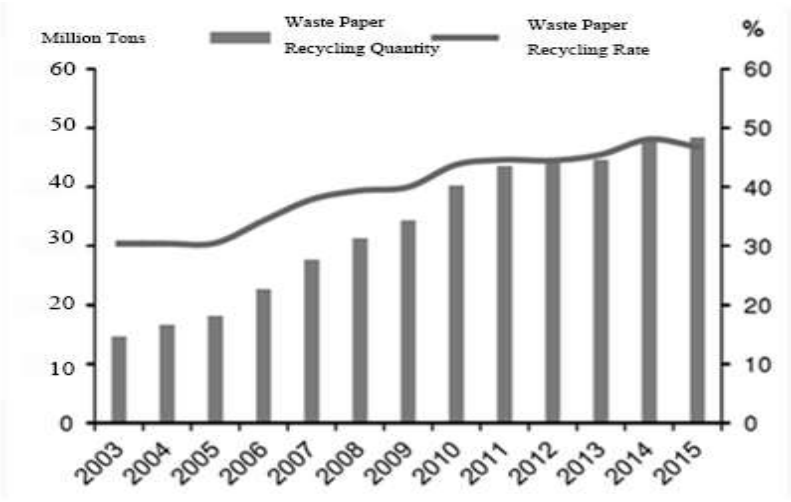


Figure 1.3.3-3: Waste paper Recycling Quantity and Rate in China

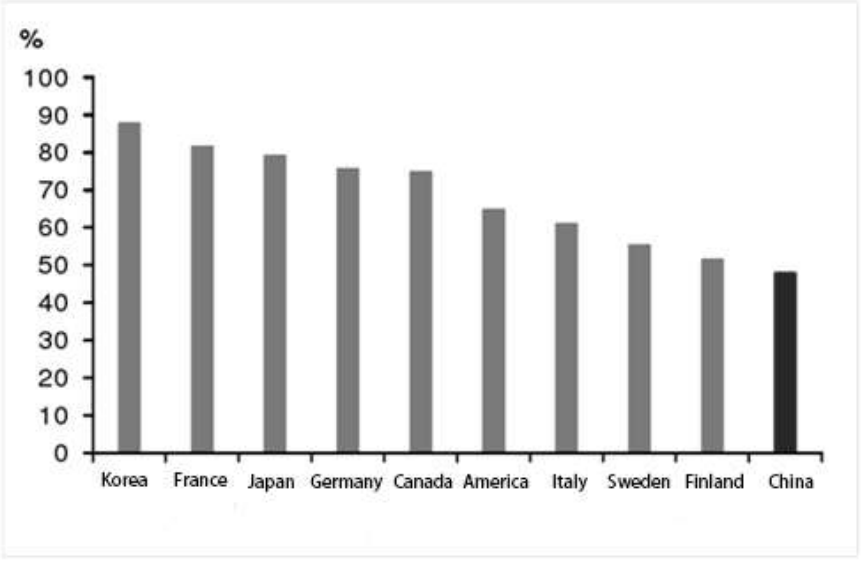


Figure 1.3.3-4: Waste paper recovery rate of ten major paper-making countries in the world in 2014

From the perspective of recycling, the waste paper has relatively high recycling value. The structure and properties of waste paper fiber are similar to those of natural plant fiber but low density and high modulus of elasticity. With a relatively low price, it has the most prominent advantage of biodegradability and renewability. There is a certain difference from the general natural plant fiber: keratinization, an irreversible physical change that the fiber cell wall undergoes during the papermaking process of the waste paper. Therefore, the swell capacity, plasticity, and brittleness of the waste paper fibers are increased. Its main applications are as follows:

- Waste paper is appropriate for preparing composite materials. The advantage of waste paper is that it does not need deinking, washing, refining and other pretreatments. Composite materials include: waste paper/thermoplastic polymer composites, waste paper/cement-based composites material, waste paper/biodegradable resin composites, etc.
- Waste paper has different functional properties and can appear in different forms, such as powder, sheet, film, fiber and solution after being modified through specific physical or chemical treatment. Thus, the functional materials developed from waste paper have great flexibility and wide application. Adsorption materials, thermal insulation materials, refractory materials and so on are more studied now.
- Waste paper can also be recycled into cushioning materials and pulp molding materials in packaging materials (Zhang et al., 2008)

The utilization rate of waste paper in China increased to 73.4% in 2013, which reached the best level in history, given the fact that this number was only 58.2% in 2004. However, in 2016, it dropped to 72.0%, which was 0.6 % lower than that in 2015. At present, according to the recycling situation of paper products in the world, the utilization rate of waste paper in China is relatively high and has reached a first-tier level among the world (Guo, 2017). In Europe, the recycling rate of waste paper reached 71.7% in 2013. (ERPC, 2013) The amount of waste paper recycling and reuse continued to grow steadily, while paper consumption remained at over 57 million tons, showing a decreasing trend, compared with 18 million tons at the beginning of 1998 (2014). In 2008, only 38.8% of the raw pulp was used in Japan's paper industry, and the recovery rate of waste paper was as high as 75.1% and the utilization rate of waste paper was 61.8%. Their performance in both of these two indicators were in the front rank of the world (Ding, 2010).

Instructions from the Ministry of Industry and Information Technology, the Ministry of Commerce and the Ministry of Science and Technology on accelerating the development of renewable resources industry pointed out that we should accelerate the construction of waste paper sorting and processing centers, establish large-scale waste paper warehousing and logistics trading centers in key areas, and effectively reduce the cost of inter-regional circulation of waste paper, improve the automation level and standardization level of waste paper sorting and processing, promote the technology and equipment of automatic waste paper sorting, and improve the recycling efficiency and value-added utilization level of waste paper, promote the recycling and harmless disposal of waste materials in the process of waste paper utilization, and reduce the

environmental impact in the process of waste paper processing and utilization in the future. By 2020, the domestic waste paper recycling scale will reach 55 million tons, and the domestic waste paper recycling rate will reach 50%.

The industry chain panorama and stakeholders of paper packaging in the field of e-commerce are shown below (Figure. 1.3.3-5), which also reflects the whole life cycle of paper packaging in the field of e-commerce to a certain extent. Packing paper has gone through a long process from raw material supply, production and processing, design and printing, merchant procurement, logistics and distribution, and to ultimately reach consumers, then sorted and recycled downstream, and finally returned to the process of processing pulp raw materials. In this process, many links have caused damage to our natural environment, impacted the climate, and even threatened human health. In the next chapter, this paper will focus on the environmental impact, taking the life cycle of paper packaging as the axis, and carry out literature study on related issues.

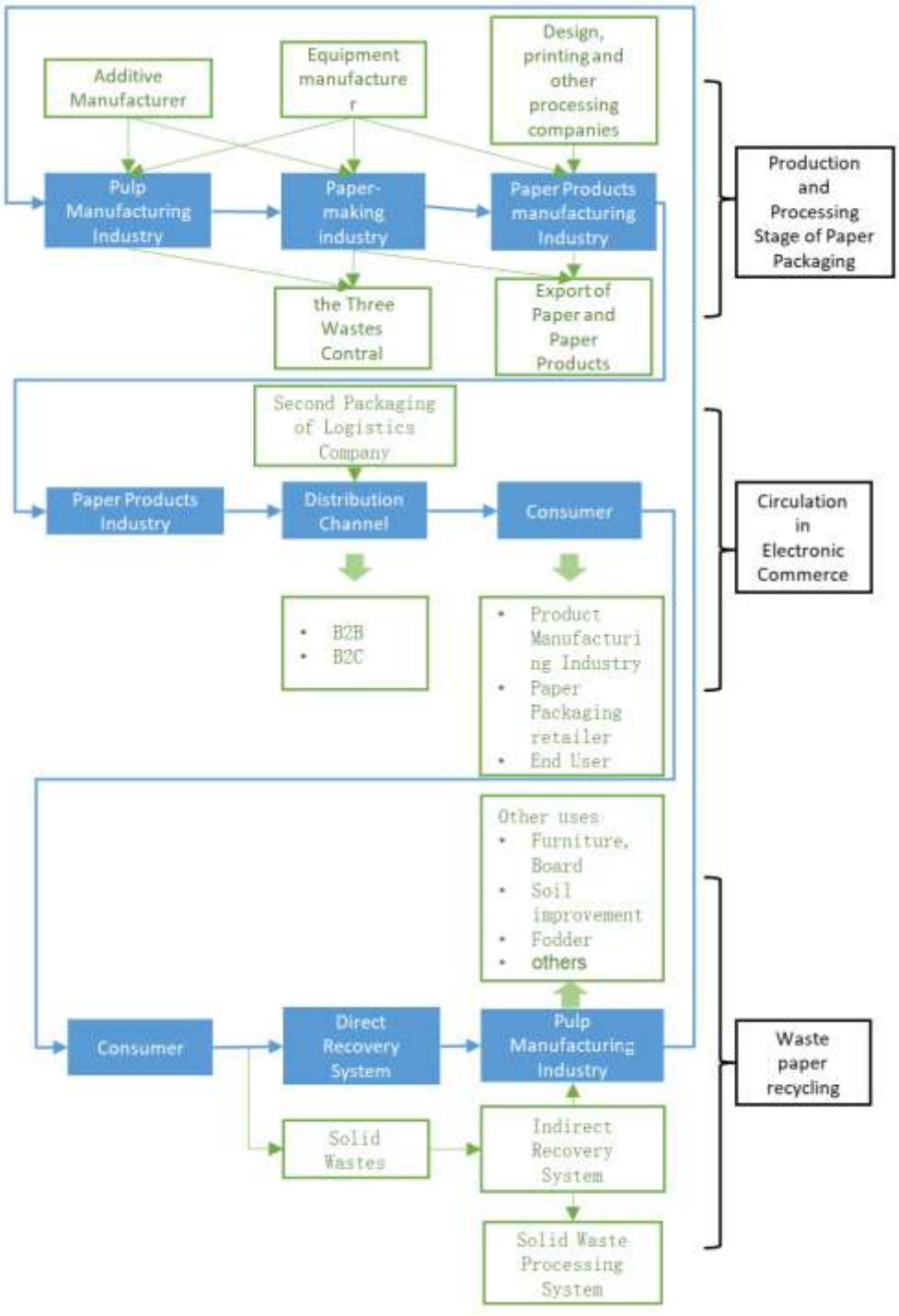


Figure 1.3.3-5: Industry Chain Panorama and Stakeholders

2. Recognition - the Impact of Paper Packaging on the Environment

The International Organization for Standardization (ISO) formulated the technical framework of life cycle assessment (LCA) environmental assessment methodology in IS014040: 1) to find out the LAC objectives, the scope and boundaries of whole life cycle; 2) inventory analysis, to identify the input (raw materials, accessories, energy, etc.) and output (water, gas, solid pollution) in different processes, and to form a life cycle inventory table; 3) to quantify the inventory data and make impact assessment; 4) Interpretation of results (Li et al., 2006). Liu et al. (2008) , in the life cycle analysis of corrugated cartons, determined the life cycle scope of corrugated cartons, which consists of five processes: production and processing of raw materials, production and processing of products, transportation and marketing process, use and maintenance, abandonment and recycle (Figure 2-1). He also pointed out that since cartons are generally considered to be disposable and do not require maintenance, and there is no obvious material and energy consumption in this process and it has little impact on the environment, thus the environmental impact analysis of the use and maintenance process was subjectively omitted(Liu, Yang and Han, 2008). This is consistent with the paper packaging industry chain described above, that is, the production and processing of paper packaging (including raw material production and product production), circulation in e-commerce (transportation and marketing process), and recycling of waste paper (waste and recycle).

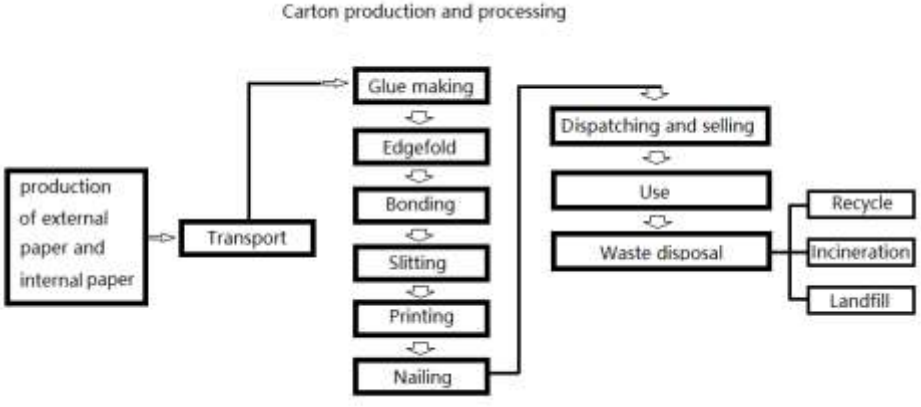


Figure 2-1: The Whole Life Cycle of Carton Production and Processing

2.1 Environmental impact of paper packaging production process

2.1.1 Consumption

From the consumption in the production process of paper packaging, it can be divided into raw material consumption and energy consumption. Raw material consumption includes waste paper for raw paper production and additives for pulping and papermaking, while energy consumption includes water, coal and electricity used in the production process etc. Ren and Huo (2010) adopted Lifecycle Impact Assessment End Measuring Method (LIME), according to the actual production survey of corrugated carton enterprises in Dalian area, using the corrugated cartons with 1 m^2 produced functional unit (3-layer corrugated cardboard, the area of surface graphic printing is about 30% of the total area). The system boundary was the whole process from raw paper supply to the production of corrugated carton finished products, and each functional unit was obtained. Data list of input (material consumption, energy consumption) in the production and processing of corrugated cartons (Table 2.1.1-1). In the process, the electricity consumption in the plate making process accounts for more than 50% of the total process electricity consumption; Steam required in the pressing, bonding and drying processes consumes a large amount of coal resources; the electricity consumption in printing process accounts for more than 30% of the total process electricity consumption (Ren and Huo, 2010). Nian and Wang (2012) calculated the energy consumption based on the production of three kinds of corrugated cardboard. The width of corrugated cardboard is 1800 mm. The type of corrugated cardboard is expressed as follows: corrugated-facing paper ration/core paper ration/facing paper ration (g/m2). The three kinds of corrugated cardboard are respectively in types of corrugated- facial tissue ration/facial tissue ration (g/m2). They are ①B-140/110/170；②B-250/140/175；③CB-250/140/140/140/175. The energy and material consumption of these three corrugated cardboard for producing 100 m^2 corrugated cardboard can be seen in Table 2.1.1-2. It can be concluded by comparison that the more cardboard layers , the higher the basis weight of base paper, the greater the production energy consumption is; However, when the number of cardboard layers and the basis weight of base paper are the same, the speed of lathe has a great influence on the energy consumption of corrugated cardboard production. The slower the speed of the lathe, the more the heat transfer loss of each production element and the greater the energy consumption.

Table 2.1.1-1: 1 m^2 Input Data List of Corrugated Carton Production and Processing (Ren and Huo，2010)

Types	Names	Quantity /(g m^{-2})
Raw Material	Base Paper	488.45
	Printing Ink	3.43
	Starch	8.47
	NaOH	0.84
	H_2SO_4	2.52
	Polyvinyl acetate (PVA) latex	10.00
	Polypropylene(PP) Packing bag	5.00
	水	831.92
Energy	Coal	89.56
	Electricity /(kWh m^{-2})	5.39×10^{-2}

Table 2.1.1-2: Energy Consumption and Material Consumption in Production of 100 m^2 Corrugated Board (Nian and Wang, 2012)

Carton Types	Lathe Speed /(m min^{-1})	Steam Consumption/kg	Coal Consumption/kg	Electricity Consumption/kWh
①	150	42.53	9.11	3.82
②	140	46.36	9.87	
③	130	78.03	13.94	3.94
	60	148.75	28.45	

2.1.2 Emission

Seen from the emission situation, waste gas, waste water, and solid waste are all produced in the paper packaging process. Ongmongkolkul et al. (2001) analyzed the process of manufacturing cartons with 15% wood pulp and 85% waste paper pulp in Vietnam, and counted the pollution emission during the whole life cycle of the manufacturing process (Table 2.1.2-1). From the table, it can be seen that there are many kinds of pollutants, such as carbon oxides, hydrocarbons, sulfur compounds, nitrogen compounds, volatile organic gases, and so on. Among them, the emission of CO2 accounts for 96% of the total emissions and CH4 accounts for 3%. In terms of emissions alone, greenhouse gases are the main gas pollution in the process of carton

manufacturing; as for water pollution, chemical requirements are the main ones; COD (chemical oxygen demand, 53%), suspended solids (32%) and BOD (biochemical oxygen demand,13%) were the dominant factors, accounting for 98% of water pollutants, and Process Waste accounted for 74% of solid wastes. This result is very similar to the quantitative analysis results made by Ren and Huo (2010) on the environmental impact of the production and processing of 1 m2 corrugated cardboard boxes (as shown in Table 2.1.2-2). We can see that CO2 and CH4 constitute the most important gaseous pollutants in all pollution emissions; COD, Suspended solids and BOD are the main water pollution factors; the solid waste in the process is the most important component of solid pollutants.

Table 2.1.2-1: Pollutant Emission from Vietnam Carton Manufacturing Process (15% Wood Pulp + 85% Waste Pulp)

Substances	Amount	Unit
Emission to air		
CO	1.16	g
CO2	510	g
CO2 (non-fossil)	310	g
H2S	$4.16*10^{-3}$	g
CH4	22.4	g
NH3	1.44	g
NOx	3.09	g
SOx	1.57	g
VOCs	$20.50*10^{-3}$	g
Emission to water		
AOX	$6.28*10^{-3}$	g
BOD	13.4	g
Chloride	1.15	g
COD	56.1	g
Fats and oils	$56.0*10^{-3}$	g
Nitrate	0.11	g
Phosphorus	$56.1*10^{-3}$	g
Sulfate	0.18	g
Suspended solids	33.7	g
TOC	0.12	g
Solid waste generation		
Plastics packaging	5.25	g

Process waste	58.60	g
Steel and metal scrap	15.12	g

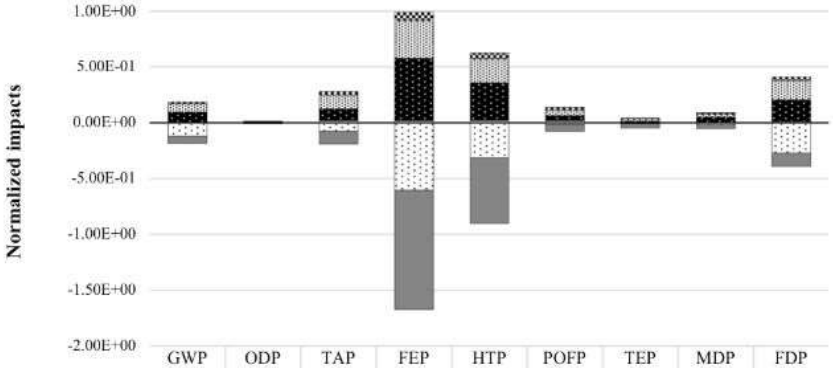
Table 2.1.2-2: Quantitative Results of Environmental Impact in the Production and Processing of 1 m^2 Corrugated Cartons

Substances	Plate-making	Printing	Boxing Procedure
CO_2	1.39	2.91×10^{-1}	2.15×10^{-2}
CH_4	1.86×10^{-4}	4.38×10^{-4}	7.70×10^{-7}
N_2O	1.86×10^{-4}	3.45×10^{-4}	2.40×10^{-6}
SO_2	7.90×10^{-3}	1.50×10^{-3}	6.60×10^{-5}
SO_X	1.71×10^{-5}	3.85×10^{-5}	1.52×10^{-6}
Soot Particles	1.90×10^{-3}	4.23×10^{-4}	5.88×10^{-6}
COD	2.80×10^{-1}	2.69×10^{-2}	-
Nitrogen	2.60×10^{-3}	7.00×10^{-3}	-
Phosphorus	2.30×10^{-4}	6.16×10^{-4}	-
Ash and Cinder	1.80×10^{-2}	4.70×10^{-3}	-
Industrial waste	2.01×10^{-6}	1.68×10^{-6}	-
Cold Wastes	2.46×10^{-7}	1.52×10^{-7}	8.11×10^{-9}

2.1.3 Impacts on Environment, ecology and human beings

The consumption of natural resources and fossil energy, as well as the emission of air, water and solid pollutants in the production and processing of paper packaging have threatened the ecological environment and human health. Some of these threats are tardy while some are dire, and some are easy to solve but some difficult to remedy. F. Corcelli et al. (2018) takes the manufacturing stage of pulp and paper mill complex in northern Finland as a model, evaluating it by SimaPro 8 LCA software, and using ReCiPe Midpoint (H) impact assessment method to obtain the category and share of environmental impact produced by pulp and paper production process, ranging from 50% of water consumption to 88% of freshwater eutrophication. Something special is that pulp production processes have contributed to Global Warming Potential (GWP, in kg CO_2 eq) (accounting for 46% of the total global warming impact), Ozone Depletion Potential (ODP, in kg CFC-11 eq) (39%), Freshwater Eutrophication Potential (FEP, in kg P eq) (55%) and Human Toxicity Potential (Human Toxicity Potential). Potential, HTP, in kg 1,4-DB EQ (46%), Metal Depletion Potential (MDP, in kg Fe eq) (42%) and Fossil Depletion Potential (FDP, in kg oil eq) (46%) and other impacts on ecology and

human health. In addition, the environmental impacts in other production links include Terrestrial Acidification Potential (TAP, in kg 1,4-DB eq), Photochemical Oxygen Formation Potential (POFP, in kg NMVOC), Terrestrial Eco-toxicity Potential (TEP, in kg 1,4-DB eq), Water Depletion Potential (WDP, in m^3) (fig. 2.1.3-1, the different environmental impacts in different production stages).



	GWP	ODP	TAP	FEP	HTP	POFP	TEP	MDP	FDP
EoL phase	-6.47E-02	-4.20E-03	-1.13E-01	-1.07E+00	-5.92E-01	-6.50E-02	-4.07E-02	-3.52E-02	-1.23E-01
Distribution phase	1.52E-02	1.00E-03	3.36E-02	7.56E-02	5.00E-02	2.74E-02	3.15E-03	1.48E-02	3.26E-02
Energy production in situ	-1.21E-01	-4.11E-03	-7.63E-02	-6.04E-01	-3.10E-01	-1.40E-02	-7.52E-03	-1.63E-02	-2.68E-01
Paper production phase	7.43E-02	5.08E-03	1.23E-01	3.37E-01	2.16E-01	4.74E-02	2.31E-02	2.53E-02	1.73E-01
Pulp production phase	8.76E-02	7.13E-03	1.07E-01	5.62E-01	3.39E-01	4.59E-02	1.17E-02	4.65E-02	1.93E-01
Forestry phase	7.85E-03	4.52E-04	1.68E-02	1.53E-02	1.82E-02	1.69E-02	1.58E-03	4.36E-03	1.26E-02

Figure 2.1.3-1: Different Environmental Impacts in Different Production Stages when Produce 1 ton Functional Unit of Paper

Ren and Huo' (2010) research results on characterization of environmental impact on environmental impact characterization of corrugated carton manufacturing process show that the processing process contributes significantly to global warming and fossil energy consumption (Table 2.1.3-1). From the perspective of greenhouse gas emissions alone, having studied the greenhouse gas emissions in the whole life cycle of paper products (mainly focusing on carbon dioxide and methane), including the planting and management stage of forest trees, pulping stage (domestic wood pulp, foreign wood pulp and recycling waste paper pulp), and paper production stage, using LCA analysis list of typical products in China's paper industry, Chen et al. (2014) drew the energy consumption in pulping and paper making process (Table 2.1.3-2 and 2.1.3-3 for detailed greenhouse gas emissions per unit product list). Chen et al' research shows that greenhouse gases produced in the production of waste paper pulp and imported pulp are several times higher than that in direct wood pulping production(Chen et al., 2014). This result raises questions about the recycling of waste paper. Ongmongkolkul et al.(2001) suggested in his research that the production and consumption of cartons should be reduced by prolonging the service life of cartons, i.e. by reusing cartons to reduce the environmental and human hazards caused by the production process of

cartons. There is no doubt that recycled waste paper pulping has more adverse effects on the environment, but it cannot decide whether to reduce recycling and increase the use of logs, but also consider the impact of waste paper on the environment in the whole recycling process and solid waste treatment process.

Table 2.1.3-1: Characterization results of environmental impacts of 1 m^2 corrugated box production and processing

Impacts	Plate-making	Printing	Boxing Procedure	Total Amount
Global Warming	1.45	4.03×10^{-1}	2.23×10^{-2}	1.88
Aquatic ecotoxicity	5.54×10^{-4}	2.67×10^{-4}	5.94×10^{-8}	8.22×10^{-4}
Land ecotoxicity	5.21×10^{-5}	8.48×10^{-6}	1.35×10^{-6}	6.20×10^{-5}
Acidification	1.24×10^{-2}	2.20×10^{-3}	9.81×10^{-5}	1.47×10^{-2}
eutrophication	1.90×10^{-3}	3.80×10^{-3}	4.72×10^{-7}	5.62×10^{-3}
photochemical oxidation	3.29×10^{-6}	2.45×10^{-6}	4.61×10^{-7}	6.20×10^{-6}
Solid Waste	1.06×10^{-6}	2.77×10^{-6}	8.11×10^{-12}	3.83×10^{-6}
Energy Consumption	1.45×10^{1}	6.42×10^{-7}	2.36×10^{-7}	3.66×10^{-6}
Fossil Energy Consumption	1.45×10^{1}	3.51×10^{0}	7.84×10^{-1}	1.88×10^{1}
Human health impact (carcinogenic effect)	1.87×10^{-4}	9.03×10^{-5}	2.29×10^{-8}	2.78×10^{-4}
Human health impact (chronic disease)	1.41×10^{-7}	6.75×10^{-8}	3.41×10^{-11}	2.08×10^{-7}

Table 2.1.3-2: Production of Greenhouse Gas Emissions from Production of 1 kg Pulp

Types of Greenhouse Gas	Wood Pulp	Market Pulp	Waste paper Recycling pulp
CO_2	117.00	400.62	548.29
CH_4	1.42×10^{-2}	1.23×10^{-4}	5.16×10^{-3}

Table 2.1.3-3: Production of Greenhouse Gas Emissions from 1 kg of Different Packaging Paper

Types of Greenhouse Gas	Packaging Paper	Corrugating Medium	Boxboard Paper	White Board Paper
CO_2	141.56	82.83	92.00	117.41
CH_4	0.12×10^{-2}	5.31×10^{-3}	6.44×10^{-3}	8.33×10^{-3}

2.2 Environmental impact of Paper Packaging Recycling process

Domestic waste treatment can generally be divided into three ways: recycling, incineration and landfill. Recycling can be divided into three ways: 1) to maintain its original functions and directly recycle, such as reusing beer bottles after cleaning; reusing used clothes and second-hand articles; 2) not to maintain its original shape and performance, but to maintain the basic properties of its materials, such as waste metal recycling, waste paper recycling, glass recycling, etc. (3) not to maintains its original morphology, usability and basic properties of materials, but to maintain some of its molecular characteristics, such as aerobic composting and anaerobic fermentation of biomass organic waste. Recycling pulping is the main method for the treatment of waste paper packaging products. Although the overall recovery rate of waste paper in China (direct recovery plus indirect recovery) is less than 50% (Chinabaogao, 2017), the recycling efficiency of cartons and packaging paper is relatively high. About 90% of them can be returned to the paper mill for reprocessing and utilization (Zhou et al., 2010), while the rest are treated in the form of domestic waste (landfill, incineration, etc.) or come into the natural environment.

In the field of electronic commerce, there are always some other materials on the corrugated carton packaging, (such as electronic waybill and tape), which makes it difficult to recycle efficiently and likely to cause additional environmental impact. Liu et al. (2008) analyzed and compared the environmental impacts of incineration (power generation), recycling (pulp) and landfill on the same number of waste corrugated cartons (Fig. 2.2-1). The overall environmental impact of incineration (power generation), recycling (pulp), landfill increases successively. As incineration power generation saves the consumption of fossil fuels such as coal and oil, its overall environmental impact is negative; the overall environmental impact of recycled paper pulp from cartons is relatively small because of the saving of raw materials used in the production of base paper. On account of the large energy consumption in the pulping process, the two environmental impacts of fossil fuel and climate change are relatively significant; while landfills has the most serious overall environmental impact due to methane, ammonia and other gases cartons decompose, as well as the toxic and harmful substances decomposed from printing ink on paper packaging that overall pollute the air, water and soil. Therefore, improving the recycling efficiency of paper packaging (even all paper products) or reducing the paper content in landfills (including natural inflow into the environment) can be considered as one of the effective methods to reduce environmental impact.

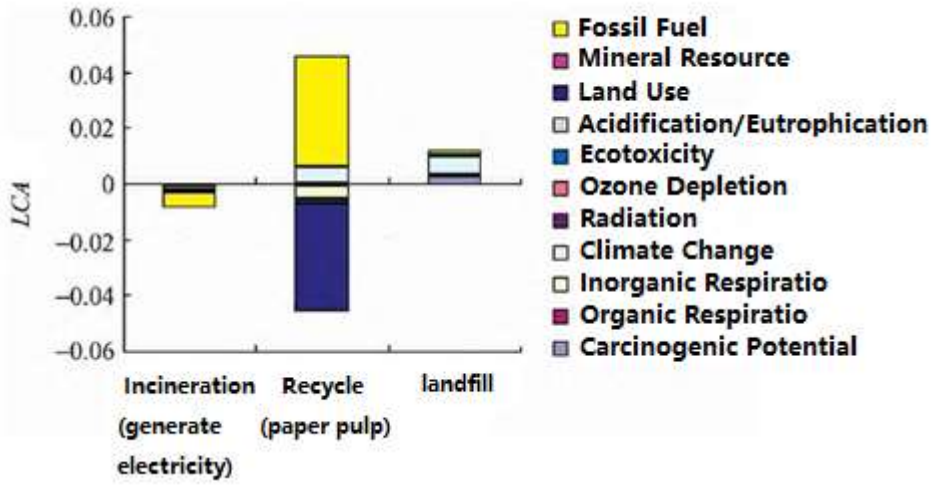


Figure 2.2-1: Environmental Impact Comparison of three Waste Treatment Methods

From the perspective of comparison between waste paper recycling and wood-based paper making, waste paper recycling not only saves a lot of wood raw materials, but also weakens the environmental impact in many other aspects. In the pulping stage of waste paper, the steaming and washing processes in wood pulping can be omitted, and the consumption of chemical raw materials, water and energy can be reduced. One ton of pulp produced cost by waste paper can save about 1,508 yuan compared with wood production (Zhao, 2005). Waste paper regeneration can reduce wastewater discharge and pollution load. Compared with the production of 1 ton chemical wood pulp, the production of 1 ton waste paper pulp can reduce wastewater discharge by 120m^3, SS discharge by 50 kg and BOD_5 discharge by 33 kg (Yang, 2003). In addition, if waste paper is not recycled but being incinerated or buried, 1 ton of waste paper will produce 1,470 kg CO_2 by incineration, and anaerobic degradation of landfill can produce 730 kg CH_4. Merrild et al. (2009) analyzed greenhouse gas emissions and global warming impacts in waste paper recycling process. The analysis framework includes three parts: upstream indirect emissions, direct emissions and downstream indirect emissions. Direct emissions mainly come from energy use of material recovery facilities. Upstream indirect emissions are defined as energy supply and fixed facilities such as electricity and natural gas. Downstream indirect emissions come from subsequent waste paper material reproduction. Direct emissions of greenhouse gases are equivalent to 1-29 kg of CO_2/t, and indirect emissions from upstream are equivalent to 3-9 kg of CO_2/t, which are negligible compared with downstream emissions. The downstream emissions are about 490-1,460 kg CO_2 per ton of waste paper; if we deduct the

greenhouse gas emissions from paper production saved by waste paper regeneration, the emissions are - 1270-390 kg CO_2 per ton; and if we assume that the saved wood is used as fuel instead of fossil fuel, the emissions are - 1850-4400 kg CO_2 per ton, which means that the waste paper regeneration can reduce a lot of greenhouse gas emissions compared with wood-based paper making.

In conclusion, it is the processing and production link that make the most significant environmental impact link in the whole life cycle of paper packaging, including raw material production and carton production. In this process, gas pollutants are mainly greenhouse gases like carbon dioxide and methane emissions from fossil energy consumption, followed by sulfides, nitrogen oxides and volatile organic gases; impacts on water are water consumption and water pollution (including chemical oxygen demand, suspended organisms, and biochemical oxygen demand); solid pollutants are mainly produced in the production and processing process. In addition, the efficient recycling of paper packaging (and other paper products) has saved timber, reduced land use and avoided some process pollution, on the other hand, increased energy use and greenhouse gas emissions. Some of these environmental impacts are regional (like groundwater pollution), some are global (like greenhouse gas emissions), some are easy to solve (like solid waste from processes), and some are difficult to recover (like energy consumption). These effects are constantly consuming the function and value of resources and environment, the public goods, and directly threaten human beings, whether within or between generations. Therefore, through in-depth interviews and other means, this paper will further study the disadvantages of excessive paper packaging, and try to propose a multi-level feasible solution to the problem.

3. Review-Relevant Policy Making and Practical Experience at Home and Abroad

3.1 Summary of Domestic Relevant Policies and Regulations

This part teases out and summarizes the relevant policies and regulations concerning paper product packaging issued in China in recent years. Since the 18th National Congress of the CPC, the CPC Central Committee and the State Council, guided by Xi Jinping Thought on Socialism with Chinese Characteristics for a New Era, thoroughly implemented Xi Jinping Thought on ecological civilization and the spirit of National Conference on Eco-environmental Protection, further carried out the plans for air, water and soil pollution prevention action, continuously pushed forward the reform of the solid waste import management system, accelerated the construction of waste treatment facilities, and implemented the domestic waste classification system. Solid waste management has made steady progress. At present, with the rapid development of e-commerce, the problem of garbage disposal has been paid more and more attention.

In November 2017, State Post Bureau and other ten departments jointly issued a document named "Guiding Opinions on Collaborative Promotion of Green Packaging in Express Delivery Industry", pointing out that it is necessary to promote source control, increase the supply of green express delivery service products, improve the efficiency of resource utilization in the field of packaging in express delivery industry, reduce packaging consumption and reduce environmental pollution. Seven key tasks are proposed in the document: first, complete the green packaging regulations and standards in the express delivery industry and promote the promulgation of the "Interim Regulations on Express Delivery". Second, increase the supply and use of express green packaging products and promote the use of recyclable packaging,

small-quantity packaging and degradable packaging. Third, implement green certification of express packaging products. Fourth, carry out pilot demonstration of green packaging in express delivery industry. Fifth, expand and strengthen the Express Green Packaging Industry Alliance. Sixth, build a demonstration city for express packaging and recycling, and support express companies to actively participate in the construction of a recycling network for renewable resources. Seventh, strengthen the publicity, guidance, education and training of green packaging in express delivery industry, and popularize knowledge of green packaging and recycling.

In January 2018, the General Office of the State Council issued "Opinions on Promoting the Coordinated Development of E-commerce and Express Logistics". Strengthening the green concept and developing the green ecological chain are required. The National Development and Reform Commission, the Ministry of Environmental Protection and the Ministry of Industry and Information Technology are required to be responsible for promoting the intensive use of resources. E -commerce enterprises and express logistics enterprises are required to carry out green process reengineering of supply chain, improve resource reuse rate and reduce enterprise costs. The Ministry of Commerce, State Post Bureau and the former Ministry of Environmental Protection are required to promote green packaging, formulate and implement e-commerce green packaging and reduction packaging standards, promote the application of Green Packaging Technology and materials, and promote the reduction of express logistics packaging. Encourage e-commerce platforms are encouraged to carry out green consumption activities, provide green package selection, and price different packages to guide consumers to use green packaging or reduced packaging.

In March 2018, Article 9 in "Interim Regulations on Express Delivery", issued by the State Council, clearly stipulates that "the State encourages enterprises and senders engaged in express delivery business to use degradable and reusable environmental protection packaging materials, and encourages enterprises engaged in express delivery business to take measures to recycle express delivery packaging materials so as to realize the reduction and reuse of packaging materials".

In June 2018, the State Council of the Central Committee of the Communist Party of China issued "Opinions on Strengthening Ecological Environment Protection in an All-round Way and Striving Resolutely for the Key Battle of Pollution Prevention and Control". The Opinions put forward requirements for the green development of the express delivery industry: "Promote green consumption, introduce standardized standards for new formats such as express delivery industry and sharing economy, and promote green products such as environmental label products and organic products".

In April 2018, the Ministry of Ecological Environment and other eight departments jointly issued the "Notice on Launching Supply Chain Innovation and Application Pilot " to guide the innovation and application of green supply chain: to promote green consumption, to intensify the publicity of green products and green packaging, to encourage the directional cooperation of "express delivery industry+ recycling industry", to guide the consumption concept of advocating nature and pursuing health, and to foster a green consumption market.

On August 31, 2018, “Law of the People's Republic of China on Electronic Commerce”was adopted. Article 52 of the law stipulates that "Express delivery logistics service providers shall use environmentally friendly packaging materials in accordance with regulations to reduce and reuse packaging materials".

On September 1, 2018, the national standards for “Express Packaging Products”(GB/T 16606-2018) were formally implemented. The choice of single and double corrugated paper materials for express packaging boxes will no longer be stipulated, and the application of low-quantitative, high-strength raw materials in the express delivery industry will be promoted. Encourage express packing cases to be reused. Increase printing of recyclable related signs.

In December 2018, State Post Bureau issued "Guidance of Green Packaging for Express Delivery Industry (For Trial Implementation)", setting out the objectives of green packaging in the industry, i.e. adhering to the work objectives of standardization, reduction and recycling in green packaging for express delivery industry, strengthening cooperation with upstream and downstream chain, and gradually realizing the reduction and reuse of packaging materials.

In January 2019, the general office of the State Council issued the "Pilot Work Plan for the Construction of a Waste-Free City ",insisting on the development of a green and low-carbon cycle, focusing on a large quantity of industrial solid waste, major agricultural waste, household waste, construction waste and hazardous waste, to achieve significant reduction in the source, full resource utilization and safe disposal, and to select typical cities for pilot testing to steadily promote the construction of a" waste-free city ".

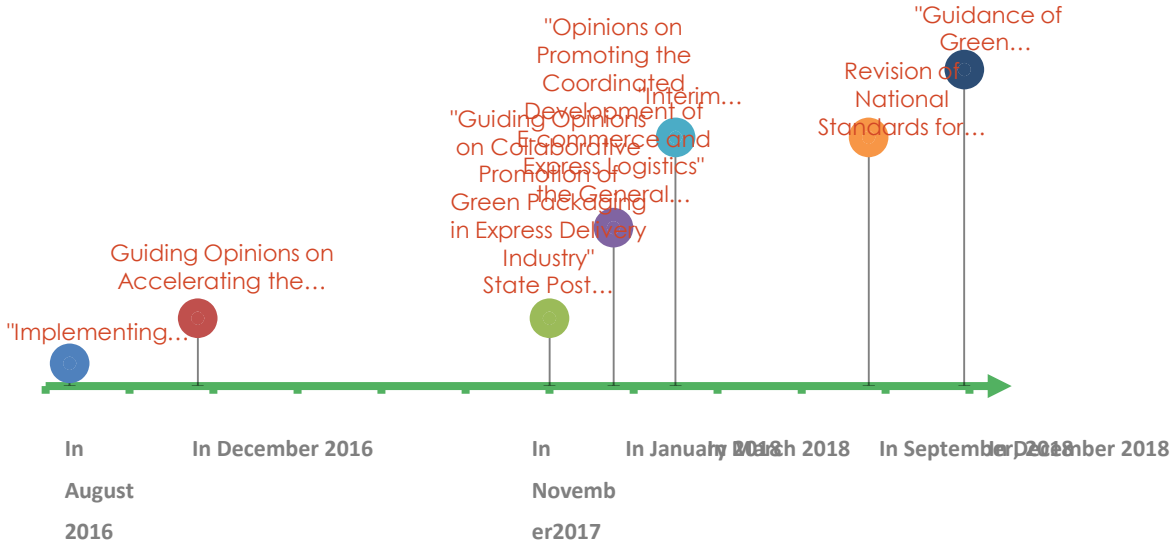


Figure3.1-1 Summary of relevant domestic policies and regulations (by January 23, 2019)

In conclusion, our country is determined to promote and develop green logistics ecological co-construction, with a positive attitude and steady pace. Through the formulation and implementation of relevant policies at the present stage, our country has gradually stepped forward to a new stage of greener environment protection, accompanied by the emergence of new problems. Paper product packaging is mostly discussed under the theme of green packaging. Green packaging is also an important part of green logistics, which once again shows that the problem of packaging cannot be solved independently. But it requires systemic consideration to solve the problem of the whole circulation chain.

3.2 Relevant Foreign Policy Making and Practical Experience

This section will first introduce the origin and connotation of EPR. On this basis, the practice cases in European Union, North America and Japan are introduced and the illumination and experience to our country are summarized. In fact, the environmental pollution and waste of resources caused by over-packaging in express delivery are not new. Taking western countries as an example, in the 1990s before the rise of electronic consumption, they faced problems such as the sharp increase of wastes and resource waste brought about by the prosperity of social economy and the prevalence of materialism and consumerism. In order to deal with the environmental pollution and resource waste caused by increasingly severe personal consumption, many countries have issued waste management policies with the principle of extended producer responsibility (EPR) as the core to reduce the environmental impact of products and promote the recycling of resources. After more than 20 years of development, the waste management system with EPR as the core has been further developed in theory and practice, and has achieved fruitful results in the implementation in the European Union, the United States, Canada, Japan and other regions and countries. In China, the *Integrated Reform Plan for Promoting Ecological Progress* promulgated by the Central Committee of the Communist Party of China and the State Council in 2015 clearly stated to "implement the EPR principle nationally and promote producers to take the responsibility for recycling and disposal of discarded products". At the end of 2016, the General Office of the State Council issued the *Extended Producer Responsibility Promotion Action Plan*. The newly launched *Pilot Work Plan for the Construction of No Waste Cities* also emphasized the implementation of EPR.

3.2.1 Extended Producer Responsibility (EPR) System

Extended producer responsibility, also known as extended product responsibility, was first proposed by Swedish environmental economist Thomas Lindhqvist in the 1990s. He defined EPR as a policy principle, that is, by extending the responsibility of product manufacturers to all parts of the whole Life cycle of products, especially to the recovery, recycling and final disposal of products, the product system is promoted to improve in an environmentally friendly direction throughout the Life cycle of products (Lindhqvist, 2000). Lindhqvist believed that the producer's full responsibility includes the following four categories (Figure 3.2.1-1):

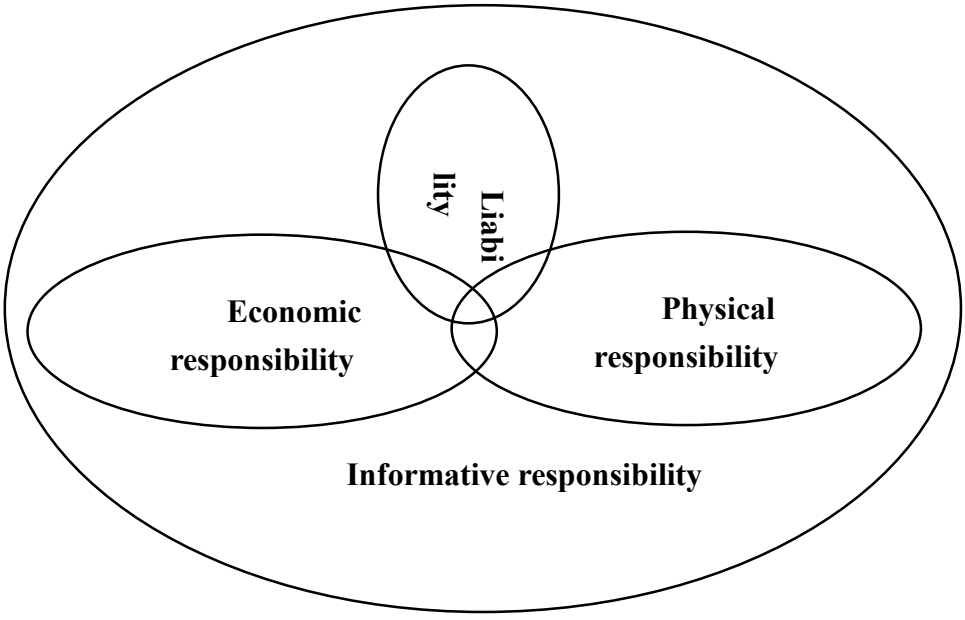


Figure 3.2.1-1 producer's full responsibility (Lindhqvist, 2000)

(1) Product Liability refers to the liability arising from proven environmental damage caused by products. The scope of this responsibility is defined by legislation and can be generated at all stages of product Life cycle, including the stage of use and final disposal.

(2) Economic responsibility refers to the total or partial cost paid by a producer to manage waste products, such as the cost of collecting, recycling or eventually disposing of the products;

(3) Physical responsibility, also named material responsibility, tangible responsibility, or behavioral responsibility, refers to the physical management of products and/or

product impacts that manufacturers are responsible for participating in. This responsibility actually includes the design, manufacture and application of recycling technology, research and development, and even the organization and management of the recycling system.

(4) Information responsibility refers to the information about the environmental characteristics of the products produced by producers.

Other scholars, government agencies and various organizations have also studied EPR and continuously expanded and completed its connotation after Lindhqvist. For instance, in the original definition, producers were defined as producers of products. For example, in a report, the Organization for Economic Cooperation and Development (OECD) defined EPR as: producers and importers of products must take most of the responsibility for the environmental impact of their products throughout Life cycle, including the upstream impact of raw material selection and product design, the mid-stream impact in the production process of products, and the downstream impact of post-consumer recycling and disposal (OECD, 2001). According to this definition, importers are identified as producers for some imported products, thus take most of the responsibility. However, this definition of producers and importers as the subject of waste liability is not acceptable in the United States. Most organizations, institutions and scholars from the United States believe that there are many actors in the product chain except for producers, such as raw material suppliers, product sellers (including retailers, distributors and suppliers), users and consumers, waste disposers (including managers, transporters and waste sorters), and governments that perform regulatory functions, etc. The responsibility of the product should be distributed fairly according to the roles and functions of all actors in the product chain, and does not advocate protruding the responsibility of producers. This view that the government, consumers and producers share the environmental impact produced in each stage of the product chain is commonly referred to as Product Stewardship (Gardner, 2013). This view is quite popular in North America and Australia. However, some scholars believe that in the process of practice, it is difficult to clearly divide the responsibilities of various subjects, or policies cannot be implemented because too many subjects' responsibilities are weakened. Therefore, too much emphasis on sharing or dividing responsibilities will make EPR policy difficult to implement.

At present, different countries or regions have different definitions of the content, scope and subject of EPR. For example, Europe emphasizes the main responsibility of producers, while the United States emphasizes the sharing of responsibilities, which

means main actors in the product chain has certain responsibilities. In general, most of the present EPR studies agree that responsibility sharing is essential in EPR policies. For example, consumers have the responsibility to return product packing to fixed waste collection points, but there must be one subject who bears the fundamental responsibility, and the responsibilities of all subjects must be clearly defined.

3.2.2 International Experience

Based on EPR principle, different countries and regions have formulated different policies to solve the problems of environmental pollution and resource waste caused by abandoned product. Some scholars have summarized these policy tools based on the EPR principle into three major types (Table 3.2.2-1), i.e. mandatory, economic and informative instruments. Different types of policies have different emphases and different distribution and extension of responsibilities. It can be seen that designing waste management policies based on EPR principle has a lot of flexibility and is not limited to a single policy type. This section will introduce the practical experience in Europe, North America, Japan and other countries and regions. In addition, since express packaging attaches to packaging products, this section will focus on the EPR policy for international packaging materials.

Table 3.2.2-1 policy tools based on the EPR principle (Tojo, 2004)

Names	Forms
Mandatory instruments	Collect and/or recycle abandoned products to meet the collection, reuse (including re-filling) and recycling index, to meet the environmental appropriate treatment standards, to meet the minimum standards for recycling of raw materials, product standards, etc.
Economic instruments	Raw Material/Product Tax, Subsidies, Advance Disposal Fee System, Deposit-Return System, Tradable Recycling Quota
Informative instruments	Report to the competent authorities, mark or label products and components, negotiate with local governments on the collection network information, inform consumers about producers' responsibility/information that consumers need to know in order to achieve the source separation of certain wastes, and provide recyclers with information on product structure and substances used.

Europe

Europe is the region with the earliest and most mature EPR policy. At present, the European Union has passed EPR policies for four categories of products, namely,

packaging, end-of-life vehicles, Waste Electrical and Electronic Equipment (WEEE) and batteries and accumulators. Some EU member states have also issued EPR-based waste recycling policies for different types of products such as waste oils, tires, textile and graphic papers (da Cruz, Ferreira, Cabral, Simões, & Marques, 2014)

Taking packaging products as an example, Germany issued the Law on Avoiding the Production and Recycling of Packaging Wastes in 1991, which is the first waste product management law enacted under the guidance of EPR principles in the world. The regulations require manufacturers and distributors to take full responsibility for their product packaging, recycle their product packaging, and reuse or recycle the effective parts. Due to the successful model of EPR in Germany, the European Union issued the Packaging and Packaging Waste Directive (94/62/EC) in 1994, which was revised in 2004. The EU packaging regulation shifts the responsibility of municipal authorities on collecting, classifying and recycling packaging waste to private enterprises. At the same time, the recovery rate of different types of packaging materials is limited, in which the recovery rate of paper and paper products packaging is required to reach 60%. In response to this bill, many manufacturers have chosen to set up a special company to recycle and dispose their product waste individually or jointly. Such an organization is called the Producer Responsibility Organization (PRO). Taking Germany as an example, after the adoption of the packaging detective, 95 companies including retailers, consumption product manufacturers and packaging manufacturers established DSD Company (Duales System Deutschland Company) in order to exempt from their direct substantive obligations. This company will provide a system operated by private entities parallel to the public waste management system established by the government. Therefore, it is also called Dual Model and is imitated by many countries and regions. At the same time, in order to prevent monopoly, German law also requires producers to establish two or more producer responsibility organizations. This kind of regulation is also believed to strengthen competition and improve recycling efficiency. Countries like France, Belgium, Czech Republic are different. Instead of establishing a new recycling system, their producer responsibility organizations sign various agreements with the government (e.g. outsourcing to the government) and use the government's existing waste management system to recycle and reuse waste products. This model is generally known as the "Industry- Municipality Model". There is also a Tradable credits model, mainly used in the UK. In this mode, product manufacturers or importers purchase Packaging recovery note from producer responsibility organizations to prove their compliance with relevant laws. In Britain, the government is responsible for waste collection tools, while producer responsibility organizations are responsible for recycling or disposal (Arnaud, 2017; da Cruz et al., 2014).

Since the implementation of Packaging and Packaging Waste Directive in EU, the recycling rate of packaging waste in various countries has basically maintained an increasing trend year by year. Taking paper products packaging as an example, the average recycling rate in the 28 members of the EU has increased from 75.7% in 2005 to 85% in 2016 (Table 3.2.2-2).

Table 3.2.2-2 Recovery of Paper Packaging in Some European Union Countries from 2006 to 2016 (%)(da Cruz et al., 2014)

Countries/Year	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
the 28 members of the EU	73.3	75.7	78.4	80.9	83.4	83.5	83	83.9	84.7	82.5	83
Belgium	83.3	89.1	92	89.4	88	89.8	90.4	89.8	89.1	90.6	90.7
Germany	82.1	80.2	80.2	87.7	91.1	90.2	88	87.6	88.2	87.3	85.7
Spain	69.2	71.4	70	73.4	76.7	76.1	76.6	77.8	75	78.2	76.9
France	80.9	84.6	89	86.9	85.6	91.9	88	91.8	95.8	94.1	92
Italia	66.6	66.6	69.7	73.8	80.4	78.7	79.5	84.5	84.6	78.7	79.7
Netherlands	71.7	94	93.8	96.4	94.8	89.9	88.6	88.9	88.2	85.9	85.4
Austria	86.4	87	83.5	85.4	84.8	84.5	84.5	84.9	84.3	84.9	84.9
Sweden	72.2	72	73.5	74.1	74.2	69.6	75.5	76.8	78.4	79.3	81.7
England	74.2	78	79.3	79.7	83.9	81.9	84.8	86.5	89.4	73.1	77.2

Asia

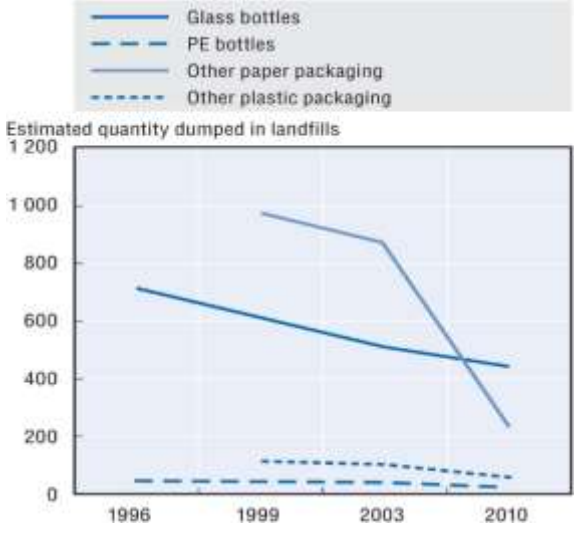


Figure 3.2.2-1 Landfill Quantity of Packaging Wastes in Japan

Japan, South Korea and Taiwan are also among the earlier countries and regions to practice Extended Producer Responsibility Thought. Among them, Japan was the first country to accept Extended Producer Responsibility Thought, and its relevant legislative system and policies are relatively mature. Since 1995, Japan has issued two waste management bills with EPR principle as the core (Chen Chen, 2007), namely Promotion Law on Classified Collection and Recycling of Containers and Packaging and Law on Recycling of Specific Household Appliances. According to the bill, municipal authorities have the entity and economic responsibility to collect Packaging Waste discarded by consumers. Producers or sellers have economic responsible for recycling or disposing of packaging waste collected by the government. The Japanese government has set up a producer responsibility organization responsible for recycling and disposing of waste, namely the Japan Container and Package Recycling Association. This organization is responsible for outsourcing specific recycling activities to qualified recyclers or companies. At the same time, it is stipulated that producers can participate in the establishment of producer responsibility organizations and allow the existence of multiple producer responsibility organizations. But in fact, there is only one producer responsibility organization named Japan Container and Packaging Recycling Association. In addition, the Japanese government is also responsible for raising public awareness and promoting proper classification through educational activities. In principle, all producers need to mark their products to facilitate waste classification. After more than ten years of implementation, the landfill rate of containers and packages in Japan has decreased significantly (Figure 3.2.2-1), while the number of various packages has also increased year by year.

North America

The United States and Canada are also early countries that have implemented EPR system and policies. For example, at present, more than 10 states In the United States have set up beverage bottle recycling laws to remove excess plastic waste from landfills by making manufacturers pay for the collection and recycling of beverage bottles. In addition to plastic bottles, 32 U.S. states already have EPR regulations for specific products, making producers responsible for discarded televisions and other electronic products. Canada regards Extended Producer Responsibility as a management tool for a broader market economy, which is used for other waste management besides packaging waste, such as waste batteries, electronic equipment, durable consumer goods, transportation vehicles and automobile tires (Gardner, 2013; Hickle, 2014). For example, British Columbia in Canada, has formulated relevant regulations on waste lubricating oil treatment since 1992. Under this regulation, more than 40 million litres

of waste lubricating oil are recovered every year through the extended producer responsibility system. In 1994, this province passed an extended producer responsibility system for waste paints. In 1997, regulations on solvents, flammable liquids, household pesticides, gasoline and pharmaceuticals were also established. Through the introduction of extended producer responsibility system in British Columbia, the local government's waste management costs have decreased significantly.

Compared with the mandatory legislative stipulation at the national level in Europe and Japan, the United States and Canada are more inclined for state governments to explore various ways of waste management. Although the states and localities in the two countries have the impetus to enact EPR legislation, it is still far from establishing EPR federal laws. In addition, most of the local government decrees in the two countries stipulate that producers are encouraged rather than required to be responsible. Finally, in North America, the fair distribution of product recycling responsibilities according to the roles in the industrial chain is more emphasized, rather than the main responsibility of producers. It seems fair, but in fact it weakens the responsibility of producers and reduces the possibility of stimulating their motivation to improve product design.

3.2.3 Experience Summary and Enlightenment

Countries in the world implementing EPR policies have both success and failure. On the whole, the following points should be taken into consideration when formulating EPR policies: (1) At the legislative level, the concept and objective of EPR should be clarified (the aim of EPR is not to recycle products, but to promote producers to improve their product design from the perspective of all life cycle so as to reduce the environmental impact of their products); (2) Responsibility can be shared, but the responsibility in every role must be clearly defined, including the entity responsibility, economic responsibility and information responsibility of the product. (3) A clear and stable framework must be established to ensure fair competition and provide adequate supervision and equal rules for all, especially to prevent monopoly of producer responsibility. (4) To ensure the transparency of EPR policy-related information, such as the implementation of the policy, sources of PRO's funds, etc.; (5) The government or relevant administrative agencies shall be responsible for supervising and reviewing the implementation of EPR policies, and shall ensure that there are appropriate administrative enforcement measures to severely punish offenders.

4. Observation-Opinions and Viewpoints of Industry Experts

In the first part, we have elaborated on the panorama of the packaging industry chain in the field of e-commerce consumption, and analyzed the possible environmental impacts in each link. It clearly shows that solving the over-packaging problem and reducing its environmental impacts are closely related to each stakeholder.

Generally speaking, the proposal of a multi-level feasible solution must comprehensively take the views of all stakeholders into consideration, give ear to different voices and demands, and integrate and adjust in actual situations, so as to find a plan and strategy that can be truly implemented. Therefore, in this part, through in-depth interviews with industry experts in the e-commerce circulation link, which is a connecting link between the stakeholders in the whole industrial chain, we have obtained more viewpoints and insights, thus describe a more comprehensive status quo of over-packaging in China.

Industry experts in the e-commerce circulation link are mainly responsible people from large e-commerce (self-supporting) platforms and leading logistics enterprises. In this core link between the preceding and the following, they are both purchasing suppliers in upstream packaging manufacturing and commodity manufacturing industries as well as suppliers of downstream Individual consumers. They have a good grasp and profound insight into the main viewpoints and behaviors of these two parts, and combining with their own industry conditions, they can give a comprehensive solution to our problems.

This report mainly elaborates and analyzes the current situation of the industry and does not include consumer psychology research. Therefore, the view of ordinary individual consumers on over-packaging is not taken into consideration.

4.1 How to correctly understand and recognize "over-packaging" is a key to solve the problem

The subjectivity of the concept of "over-packaging" determines the fact that it cannot be strictly defined. Therefore it is meaningless to dwell on how to define its existence and definition. In this case, only the perspectives of all stakeholders are correctly listened to and understood as well as mutual trust and respect are established on this

basis, can the cooperation of the whole industrial chain be further promoted to improve the "over-packaging" problem. For commodity suppliers, what consumers see as "secondary over-packaging" is actually necessary in some specific commodity scenarios, because it is an additional product to maintain brand image; for the paper product packaging manufacturing industry, the size, the number of layers and grinding resistance of the carton depend on the market demand, for sales and logistics platforms, customer satisfaction and packaging costs are considered first, for consumers, the demand for express packaging is highly different. The same consumer may have differentiated demand for the packaging of the goods and express packaging when purchasing different types of goods. Consumers with different consumption concepts and values are more likely to have differentiated demand. It is hard to ensure a rich variety of demands. In such circumstances, we should fully listen to the voices of all stakeholders, fully understand the perspectives of all stakeholders, fully communicate the demands of all stakeholders, negotiate and compromise in an open and transparent dialogue environment, finally reach an agreement and find the most suitable solution for the present.

At present, the public's cognition and understanding of the pollution problem in the express delivery industry are actually "excessive". Blindly expanding the packaging problem of paper products (such as "excessive packaging" and "green packaging") easily leads the public to ignore the pollution problems arising from other links. For example, the pollution gas emission and energy consumption problems arising from the logistics and transportation process are also very serious and urgent to be solved. It is fine for the public to realize the environmental harm brought by express package, but it cannot be over understood and put too much pressure. Therefore, when we cultivate environmental awareness through publicity, education and other means, we should examine the problem more comprehensively, broaden the public's vision and raise environmental awareness such as "saving resources" and "reducing energy consumption" from the source.

4.2 Promote the Completion of Uniform Profession Standards for Paper Products Packaging in Logistics and Express Industry

At present, there is no unified profession standard or specification for packaging in the logistics and express industry. Though the standard is necessary, packaging standardization is limited by multiple factors. It is obviously unwise to adopt a "one size fits all" approach. In fact, the operation specifications of packaging exist in various

enterprises and have been optimized in terms of cost accounting. They are very detailed and can be landed. However, more factors need to be taken into account to realize large-scale promotion. The most important thing is the type and size of the enterprise. It is whether the enterprise itself has enough ability to fulfill the standard. Followed by how to balance and satisfy the demands of manufacturers and customers, etc. Therefore, it is important to form industry standards, but it cannot be separated from the guidance and support by the government and relevant departments in policy formulation.

The contents involved in the uniform industry standards or specifications for packaging in the logistics express industry should be as comprehensive and widely covered as possible. As far as paper product packaging is concerned, its use and disposal involve a variety of materials, so there should be corresponding specifications from the most basic number of express carton layers, to the width and length of adhesive tape, and to the composition of printed materials, etc. For example, as the non-recyclable part of paper products packaging, the problems brought about by the end disposal of adhesive tapes are worthy of attention. Standardization of the quality and width of adhesive tapes, or the implementation of integrated carton without adhesive tapes are all strategies to solve this problem. In addition, from the point of view of environmental protection, the restrictions on plastic packaging should be stricter than paper products packaging, because the pollution caused by plastic packaging is more significant and irreversible.

4.3 Intelligent green storage and logistics have matured

When talking about "over-packaging", many people will first think of the phenomenon of "big boxes for small commodities" or "one commodity with several boxes". In fact, this phenomenon has rarely existed under the optimization of current intelligent green storage and logistics. High-tech means such as "optimizing the layout and storage of core commodities", "intelligent packaging selection " and "optimizing logistics routes" have minimized the "over-packaging" brought about by these phenomena. At present, intelligent technologies like using big data to analysis and calculation, storing commodities according to consumers' preferences and reducing unnecessary transportation links, using the intelligent system to automatically analyze and calculate the packaging scheme of each single commodity to reduce unnecessary packaging cost, or using intelligent logistics route optimization to reduce energy consumption during transportation have been applied on a large scale and are gradually maturing. However, the system is still in the process of development and optimization, and faults and problems still exist, which still need to be envisaged. In 2018, China Cainiao Smart

Logistic Network realized intelligent package selection based on big data algorithm, and exported this platform-level technology to the whole industry, helping to achieve a more matching and compact box type and raise the full box rate to 70%. Since being promoted, this technology have optimized more than 500 million packages, which is equivalent to saving 115 million postal No.6 cartons and reducing carbon emissions by more than 15,000 tons, like 848,044 Haloxylon trees are planted.

4.4 Main Responsibilities of Practice of Ecological Civilization Construction-Reduce the Responsibility of "Over-packaging" Lie in Every Link

The problem of "over-packaging" is systemic. Therefore, its solution must also be systemic. The responsibility to solve the problem lies in every link of the system so the responsibility must be clearly defined and assumed in each link. On the basis of mutual trust, mutual weight, mutual aid and mutual benefit, it should be gradually pushed forward to reach an agreement.

First of all, all stakeholders should reach a consensus on the fact that "there is no absolute over-packaging, and the responsibility to solve over-packaging lies in every link." On the basis of this consensus, through open and transparent dialogue to understand the main demands and decision-making reasons of each link, stakeholders should fully understand and build mutual trust. At present, from the perspective of logistics, "over-packaging" that has universal significance exists. Due to the packaging damage caused by improper operation in the process of logistics and transportation, the original packaging thickness and the usage of adhesive tapes are forced to increase invisibly. Relevant departments have evaluated the average number and height of packages thrown during express delivery, and found that there is almost no excessive throwing in this link of large logistics platforms, which is the result of optimization of its intelligent sorting system and distribution center, but in small and medium-sized logistics enterprises, this situation is more serious. It is easy to understand that the competition faced by commodity suppliers and express delivery industry is increasingly fierce. They first pursuit consumers' satisfaction, and the choice of paper products packaging naturally falls behind. However, the distrust of consumers to the express delivery industry has resulted in their excessive demands for express delivery paper products packaging, which has intensified the generation of "over-packaging" from another side. Therefore, in order to break this vicious circle and turn it into virtuous, it is necessary for all parties to reach consensus and trust on the cooperative solution of the packaging problem, understand each other's demands, and

accelerate the improvement of the existing problems before the solution can be optimized.

Systemic solutions are built on a complete and clear network of stakeholders and cannot be separated from the collaborative cooperation of all stakeholders. On the basis of mutual understanding and trust, it is imperative to work together for mutual benefit and find a solution that meets the demands of all parties. For example, from the perspective of commodity suppliers and e-commerce sales platforms, due to the differentiation of commodity characteristics and sales demands, the connection and communication between suppliers and distributors has become the main factor to solve or avoid "over-packaging". Goods are sold separately, and the outer packaging of some specific kinds of goods for sale is not transportation packing, but has the additional function to improve the image of the goods. In this case, secondary packaging is produced, while consumers will eventually remove both types of packaging, which forms "over-packaging". Although some common daily chemical products do not need repackaging, their own packaging is not fit for the pasting of courier receipt, so it is necessary to have external packaging. As for the "secondary packaging" caused by this reason, some suppliers and distributors have already begun to find solutions through active mutual communication, optimizing the external packaging of commodities from the supplier side, and meeting the double standards of later sales and transportation. In June 2017, JD.com jointly sponsored the "Green Flow Plan" with Procter & Gamble, Nestle, Nongfu Spring and other brands to reduce the secondary packaging of e-commerce. It is estimated that there will be 10 billion disposable packaging cartons decreased in the supply chain by 2020, which is equivalent to the number of express cartons used in the whole country in 2015.

In the process of implementing the systemic solution, many problems will inevitably emerge, which increase the resistance to implementation. It is not enough to maintain the stability of the solution system only by mutual trust, mutual supervision among all links is also essential. It is worth pondering that the impact of consumers on other stakeholders in the supervision and promotion process is sustainable. Consumer groups are stable and growing. As the object of service, its needs and suggestions will continuously urge and force service providers to make improvements; as ordinary citizens, their needs and voices are also listened to and valued by government agencies. Thanks to this, consumers can have a sustainable positive impact. Therefore, how to give full play to the consumers' supervision and promotion effect is worthy of consideration.

4.5 Make Diversification of Solutions to "Excessive" Paper Products Packaging Problem

Since 2013, various e-commerce consumption platforms and logistics platforms have begun to make efforts to realize the greening of packaging in the e-commerce consumption field, including "Smart Packaging Laboratory" of Shunfeng, "Green Action Plan" of China Cainiao Smart Logistic Network, "Green Flow Plan" of Jingdong, "Qingcheng" of Suning, "gooday" of Haier and "Packaging Laboratory" of Debang, etc. Schemes and measures related to reduction in these plans have greatly promoted the solution to the problem of "over-packaging". The diversity of solutions is obvious to all, and there are many differences in the links that need to be optimized in the implementation process.

4.6 Promote the Paper Products Packaging Recycling at Consumer End - Platform Reverse Logistics vs. Consumer Independent Application

The recycling of paper products packaging is generally considered to be the most effective way to recycle resources. How to promote consumers to recycle or utilize paper products packaging has become an important issue.

Since 2016, China Cainiao Smart Logistic Network's "Green Movement Plan" has started recycling cartons in Tmall Supermarket. At present, Tmall Supermarket carton recycling service covers 10 key cities in the country, including Beijing, Shanghai, Guangzhou, Tianjin, etc. While delivering the package, the courier in the covered area will ask consumers if they are willing to recycle the excess Tmall Supermarket cartons in their homes. After asking for permission, the courier will take the recycled cartons back to the distribution site for unified inspection and cleaning. The cartons that meet the secondary use will be labeled and will continue to be returned to Cainiao Warehouse for secondary use, while those that do not meet the requirements will be delivered to the professional processing company, based on the intelligent logistics system Platform in China Smart Logistic Network, a "Green-action Package Material Recovery Area" pilot project has been set up at Cainiao Yizhan in universities; during the double-eleven period in 2018, Cainiao's "recycling program" was launched at about 5,000 recycling points in 100 cities nationwide, recycling more than 5 million cartons from November 8 to November 14. Since March 2017, JD.com's "Green Flow Plan" has upgraded its internal recycling system to provide customers with paid recycling of idle cartons,

which will be returned to JD.com's warehousing and logistics system by couriers and encourage consumers to return paper product packages for recycling. During the double-eleven period in 2018, Suning Logistics launched “the Shared Express Box Recycle Bin Activity”, relying on Suning Store to help community express package recycling. During the double-eleven period in 2017, Haier's "gooday" logistics launched the "Different Boxes" activity, calling on consumers to reform the packing boxes of large items so as to realize the secondary use of non-express packages in daily life. Shunfeng Express launched a carton recycling activity, recycling cartons through various recycling methods, such as advocating and promoting customer recycling, customer online WeChat booking, and developing reusable "Shunfeng Boxes".

The end Consumers' motives for recycling paper product packaging are mainly divided into two categories. One is that paper product packaging, as high value-added waste, can obtain economic benefits, and the other is that paper product packaging can be used for other purposes as daily necessities. There are always different voices between encouraging consumers to return paper product packaging to form reverse logistics or encouraging consumers to form optimum use of resources consciousness to realize independent secondary application. Therefore, how to make a balance and choice between the two needs further concerted discussions.

4.7 Promote Optimization of Paper Product Packaging Design and Application-More “Green”/Recyclable

With the proposal of green logistics development strategy, optimizing the design, manufacture and application of paper products packaging has become a trend. With the unremitting efforts of all stakeholders, initial results have been achieved.

On the premise of ensuring the packaging quality of paper products, the first step to optimize the packaging of paper products is to reduce the use of materials, improve the manufacturing process and reduce the environmental impact. In 2014, Shunfeng began to change the full plate printing of cartons, document side seals and plastic bags to non-shading printing, reducing the ink consumption by about 70%, which can reduce the use of 750 tons of ink based on 150 million materials printed each year. In 2018, Shunfeng officially launched the "Fengjing Plan", developed "Fengxi" packaging, and carried out reduction and light weight reform on cartons, express bags and document side seals based on the principle of quality guaranty and quantity reduction. At the present stage, “Fengxi” packaging has covered more than 45 regions

in the country, with a total usage of nearly 4 billion. The cost of new packaging has been reduced by 4%-30% compared with that before. In 2018, Shunfeng invested millions of yuan in the innovative research and development of all kinds of packaging materials under “Fengjing Plan”. The Plan has reduced 9,901 tons carbon emission, which is equivalent to reducing the felling of 99,000 trees. The use of adhesive tape has also received attention. As a non-recyclable part, reducing the use of adhesive tape or finding a better alternative (e.g. the integrated packaging carton) is the main trend. In order to reduce the use of packing tape, Cainiao has gradually replaced traditional cartons with tape-free "zipper" cartons in the warehouse distribution system. JD.com has already optimized the adhesive tape in 2015, reducing the width of the adhesive tape from 53mm to 45mm, a 15% reduction, and reducing the use of adhesive tape by 5 million square meters per year without affecting the packaging effect of express mail. In 2016, this plan has enabled JD.com to reduce the use of adhesive tape by at least 100 million meters, which can go around the Earth 2.5 times.

It is not only the recycling at the end, but also the practice of "recyclable" concept in logistics packaging design has become a major trend. Starting from December 2017, JD Logistics's recyclable "Green Flow Boxes" have been put into use in more than a dozen cities such as Beijing, Shanghai, Guangzhou, Hangzhou, etc. The "Green Flow Boxes" can be recycled more than 20 times, saving more than 30% of the cost in a single use compared with ordinary cartons. Starting from 2016, Shunfeng started research on "recyclable" packaging materials. In 2018, Fengbox Circular Packing Boxes (which have won 15 national patents) were put into use nationwide. At present, 500,000 Shunfeng Boxes have been put into use, and more than 400,000 have actually been used, with a cumulative circulation of nearly 5 million times and a utilization rate of over 80%. The maximum circulation of a single Shunfeng Box is 41 times and is still in continuous circulation； the use of Shunfeng Boxes have covered 24 cities (regions) in the country, including all first-tier cities and 9 second-tier key cities; Shunfeng plans to invest 3 million Shunfeng Boxes in 2019, which is expected to save 150 million cartons. Debon Express proposed the concept of green folding recycling box. The courier carries the recycling box to pick up from patrons, and packs the customer's goods into the recycling box. After the goods are delivered, the recycling box is taken back and reused. In February 2018, the first batch of “Cainiao Circular Express Boxes" were put into use. They were designed to be foldable and used a "plug-pluck" ring lock design instead of adhesive tape. Each can be reused more than 20 times.

There is no doubt that the continuous optimization of packaging design and application of paper products makes people see the hope of reducing "over-

packaging" and realizing green logistics. However, behind these optimizations, the huge investment and great concentration of the industry cannot be ignored. From the early research and development design cost to the late operation and maintenance system construction cost, the production and circulation of paper products packaging involves a large amount of human and material investment, and lasts for a long time, which have formed a barrier for small and medium-sized enterprises to realize green logistics, further hindering China's overall reduction of the environmental impact of "excessive paper products" packaging.

4.8 The formulation and implementation of national policies are the key factors to promote and sustain this process

China has taken green development as one of the important strategies for national development for a long time. Since the 18th National Congress of the Communist Party of China (CPC), a series of relevant guiding opinions and documents have been issued to promote the process of ecological civilization construction, guiding the e-commerce industry and logistics industry to take measures to reduce the problem of "over-packaging". First of all, the effective landing and implementation of relevant rules and regulations must be ensured. Since September 1, 2018, China began to officially implement the newly revised national standards in the series of Packings for Express Service, which also gave corresponding instructions on the green, reduction and recycling of paper products packaging, greatly contributing to the establishment and implementation of industry standards. After this good start, how to further land and implement the new standards is very worthy of attention.

At the same time, it is necessary to draw lessons from foreign excellent policy cases, put the excellent experience into local areas, and fully take China's national conditions into consideration in the process of policy making. The establishment of policies should respect the principles of market and economy, further promote enterprises and stakeholders with incentives, and carry out top-level design guided by green logistics from the strategic level.

5. Looking Forward - Perspectives and Suggestions

5.1 Regarding Governance

Based on the current situation and trend presented in the previous background investigation, it can be seen that the Chinese government has attached great importance to over-packaging, but to improve the environment caused by over-packaging, macro-control should be carried out from the following three points:

(1) Industry Governance. Specific measures can be taken from two aspects: technological innovation and industry ethics. In terms of technological innovation, it is a direct measure to ameliorate the problem of over-packaging. At present, domestic e-commerce enterprises have tried to use intelligent storage and intelligent delivery technology to minimize the environmental problems brought about by the distance delivered. In the future, technological innovation in over-packaging should be strengthened, such as research and development in packaging materials and filling materials, use of environmentally friendly filling materials such as pearl wool and shock-absorbing paper balls, and reduce the use of non-environmentally friendly packaging materials such as plastic bags and packing tapes to further reduce the impact of over-packaging on the environment. In terms of industry ethics, environmental protection awareness should be established in many production links such as businesses, consumers and design to popularize the perniciousness of over-packaging.

(2) Environmental Governance. The specific measures can be taken from the perspective of public management. On the one hand, relevant legislation should be actively improved, such as further improving the definition of over-packaging in the "Packaging Law" to give manufacturers correct standards and norms, and to form legal basis. On the other hand, we should strengthen the legal punishment, standardize the rigor of the law enforcement process, and take compulsory measures for some over-packaging behaviors that are not changed after repeated education, so that relevant laws and regulations can be effectively implemented.

Social Governance. Solving the problem of over-packaging, requires the cooperation of consumers, owners' organizations, garbage collection and other actors. Therefore, it is important to resist over-packaging and improve the overall awareness of the society. We can popularize the knowledge and perniciousness of over-packaging to the public through TV and Internet, change the wrong understanding that "packaging equals

quality" and enhance the correct understanding of over-packaging.

5.2 Policy Recommendations

In order to further reduce the environmental pollution caused by over-packaging, combining with the domestic and foreign policy-making situation and in-depth opinions of industry experts, the research group proposed the following points for reference on the potential solutions to this problem:

First, combine excellent environmental thoughts and experiences with Chinese environment for localization. Taking Extended Producer Responsibility (EPR) as an example, it is not only a method but also a kind of thinking whose kernel focuses on the division of responsibility. Therefore, the division of responsibility boundary, the control of operation flexibility and the clarity of responsibility subject all need our deep localization. For example, in combination with the view of "Taking the Subject Responsibility of Ecological Civilization Construction - Reducing the Responsibility of Over-packing in Every Link" put forward by relevant industry experts, China should take all stakeholders, including consumers, into consideration when clarifying the subject of responsibility, which is in line with China's national conditions and the generalized EPR principle.

Second, attach importance to the opinions and suggestions of independent third parties. In the policy-making process, the third party represented by NGO and research institutions can provide more objective perspective and supporting evidence, which is conducive to balancing and maintaining various stakeholders, and at the same time can improve the effective communication between relevant government departments and various stakeholders. In addition, as the problem of over-packaging involves many professional fields, the third party can play a good role of platform, promote crossover research and cooperation, and provide a more perfect solution to the problem of over-packaging.

Third, the government and the market jointly control over-packaging. In order to form a government-led governance model with multiple subjects coexisting, we can try to study and promote the PPP model in over-packaging, and introduce market mechanism in the governance process. In this way, on the one hand, we can reduce the government's expenditure on this work and reduce the government budget pressure. On the other hand, through the introduction of multiple subjects, all parties involved in the project can form a strategic alliance to coordinate the interests of different parties,

making it easier for relevant policies to be promoted, and meanwhile playing a role in reducing risks and improving the quality of public services.

Fourth, systemically cultivate and change consumers' original recycling habits of paper packaging. As mentioned above, consumers' motives for recycling paper products at the end link are mainly divided into two categories, but are not limited to these. From the perspective of behavioristics, the decisive factor in forming and influencing consumers' recycling behavior of paper products packaging is far more than motivation. The existing theoretical models are not sufficient to fully explain the mechanism and decisive factors of this behavior, which is determined by the heterogeneity of the population. Therefore, when trying to promote consumers' recycling behavior of paper products packaging, we should first realize that the solutions must be diversified, and broaden our vision to consider from multiple dimensions. On this basis, we should find the decisive factors and possible behavior patterns suitable for specific groups of people.

Fifth, attach importance to the opening and collection of relevant data and supervise them on the basis of data. Relevant industries and enterprises should and must respect the facts when carrying out the environmental protection effects brought about by their own products or projects, and should not mislead consumers. At the same time, they should be subject to appropriate supervision and supervision. At present, most industrial production links lack monitoring and records, and some data are confidential and cannot be disclosed. It is suggested that the environmental impacts in all links can be showed more accurately through the whole industrial chain life-cycle assessment. At the same time, the preservation and analysis of basic data can provide quantitative support for the design of over-packaging solutions, provide background support for evaluating the effectiveness of solutions, and provide strong evidence for publicity and understanding of the greening process.

Sixth, further strengthen citizens' awareness of environmental protection and make the environmental protection related links a close loop. The key point which all stakeholders pay attention to remains to be focused. Enterprises more regard fulfilling social responsibility as a means of publicity, while consumers are more concerned with whether the goods they buy are in perfect condition. An effective environmental protection closed loop cannot be formed if there is no strong concept and awareness of environmental protection in all links to further strengthen green production and green consumption

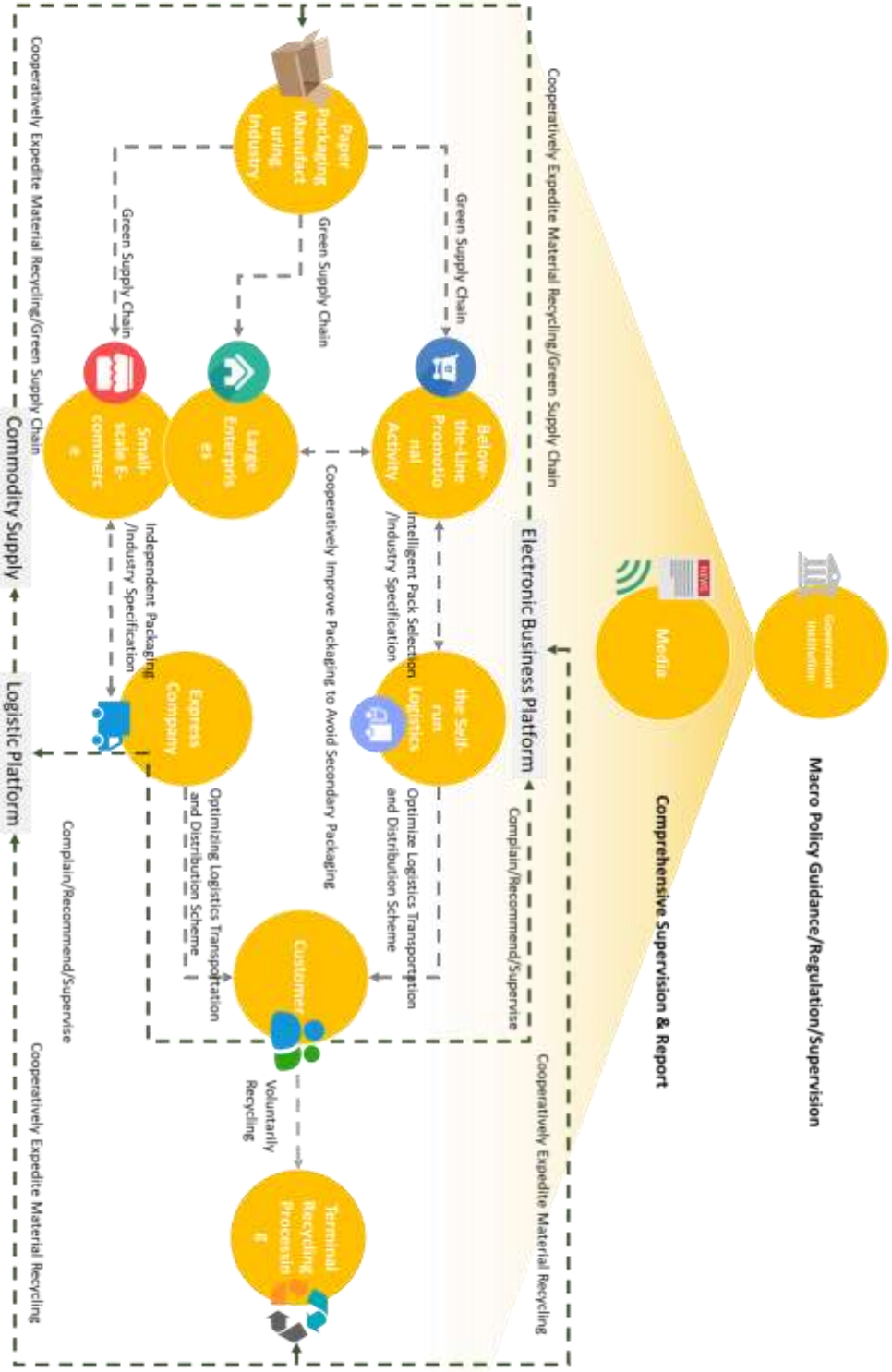


Figure 5.2-1 Framework for potential solution of over-packaging (paper packaging only) in E-commerce consumption

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