（別添２）

システムダイナミックスモデルを用いたラオス国ビエンチャン都の医療系感染性廃棄物の発生量予測

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1. 概要

ラオスの人口は年々増加するとともに経済成長[27]（図１）に伴って、廃棄物の排出量が急増している。特に病院から排出された感染性廃棄物は感染リスクが高いので、課題になっている、しかし、ラオスにおける廃棄物の問題の改善は他の分野に比較するとまだ遅れているのが現状である。そのため、環境や景観に影響を与えないように、廃棄物問題を改善することが重要になってくる。

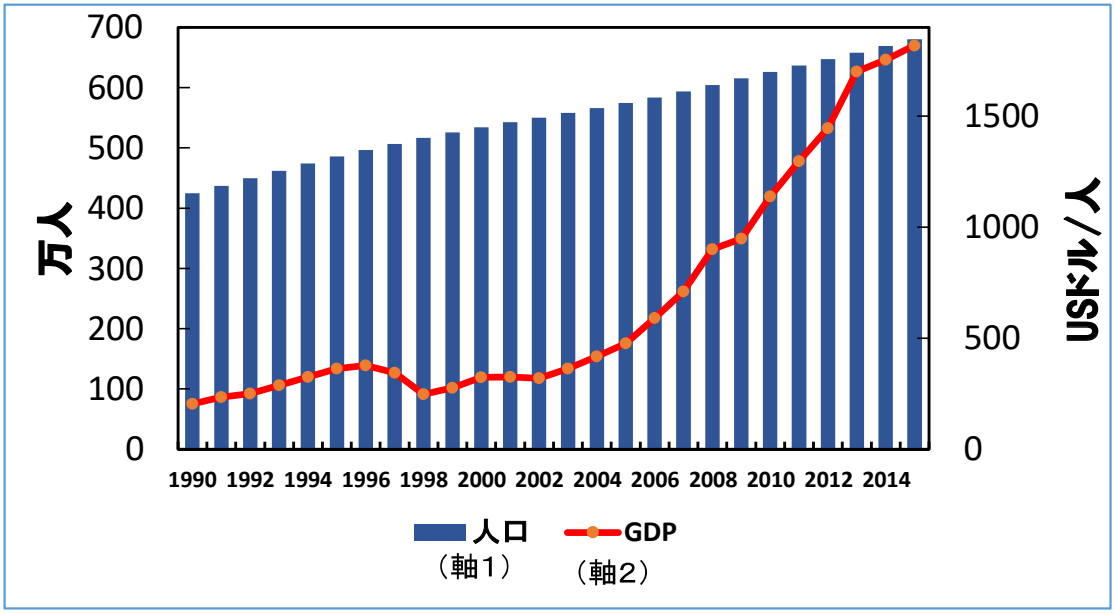

図１　ラオスの人口および１人当たりの GDP

ラオスにおいて、最も開発されているビエンチャン都には医療分野も進んでおり、医療施設が多い。また、国民保険制度も改善されており、保険に加入する者が増加することが予想される。さらに、富裕層も増加している。こうした状況によって、国内で治療する者も増え、受療率が上がると考えられ、医療廃棄物発生量が増加することにつながる。

一方で、昨年度にラオスの最終処分場及び病院の視察を行った。その結果、医療系感染性廃棄物は病院では分別することができている。しかしながら、医療系感染性廃棄物量の発生量が急激に増加したため、ビエンチャン都の KM32 の最終処分場における医療系感染性廃棄物用焼却炉（図２）の処理処理能力（120kg/day）を超えてしまっている。処理能力を超えた感染性廃棄物量は無害化されないまま埋め立て処分（図 3）をしている状況で、２次感染への懸念が非常に高まっている。

[27]The world Bank、 World Development Indicator、 2017

	
図 2　最終処分場における焼却ろ	図 3 最終処分場における処理せずに埋め立てている医療系感染性廃棄物

2. 目的

医療廃棄物問題を改善するためには現状に適切した焼却炉を建設と安定した廃棄物管理・政策を行うことが必要である。そのため、現状と将来予測の医療系感染性廃棄物量の発生量を把握しなければならない。しかし、現状では医療廃棄物に関するデータが少なく、将来の医療廃棄物の発生量の予測が存在していない。

そのため、本研究ではビエンチャン都の 3 つの大規模な中央病院と中規模な病院にヒアリング調査し、最終処分場の医療系感染性廃棄物の発生量を推計する。調査データに基づいてシステムダイナミックスモデルを作成し、このモデルによりシミュレーションを行い、ラオス国ビエンチャン都の医療系感染性廃棄物発生量将来予測を行う。また、医療系感染性廃棄物発生量変動から予想される問題必要となる新たな医療廃棄物管理・政策の提案を目的として研究を行った。

なお、本稿では「医療廃棄物」を各病院で医療系感染性廃棄物として分別された廃棄物と定義した。各病院からは医療系一般廃棄物として排出されるものもあるが、本稿では両者を区別した。

3. 研究構成

研究構成の図を図４に示す。

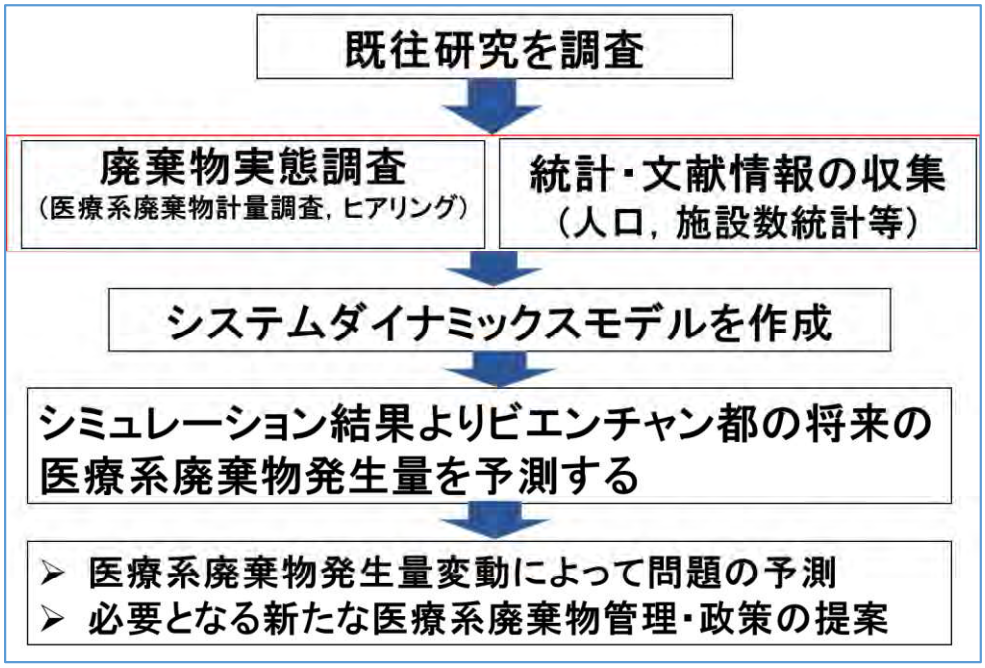

図 4：研究構成

まずは、既往研究を調査し、医療系感染性廃棄物発生量、医療機関に関するデータを得るために、ビエンチャン都における病院および最終処分場に実態調査を行い、かつ、統計局の統計提供センターに訪問し、人口や文献などのデータを収集した。次に実態調査のデータを基づいて、システムダイナミックスモデルを作成し、シミュレーション結果よりビエンチャン都の将来の医療廃棄物発生量を予測した。

４．研究方法

本研究では２つの柱が構成されている。一つ目は実態調査であり、もう一つは実態調査データに基づいて、システムダイナミックスモデルを作成し、シミュレーション結果よりビエンチャン都の将来の医療廃棄物発生量を予測する。

4.1.実態調査および調査結果

4.1.1.病院および統計局

ビエンチャン都における調査時間が限られているので、全ての病院を選定するのは困難であるため、3 つの大規模な中央病院（Mahosot、Setthathirath、Mittaphab 病院と中規模な病院(109 病院)と最終処分場を研究対象として選定した。研究対象の位置を図 5 に示す。

図 5 研究対象の位置

各病院に病床数、入院者数、外来者数、廃棄物に関するデータを入手し、さらに今後、の計画のヒアリング調査を行った。統計局に訪問し、人口や受療率などのデータを収集した。

4.1.2.最終処分場

2017 年 3 月 10 日から 3 月 29 日にかけて、KM32 最終処分場を訪問し、医療廃棄物の受入れ量と焼却量を計測した。また、過去 2 年間の KM32 最終処分場での医療廃棄物受入れ量の記録も収集した。

図 7 より医療系感染性廃棄物は回収する際に良く分別できていないことがわかった。かつ、入れるものは容器セーフティボックスではなくて、袋であるため、作業者が気を抜けば、リスクが高い作業である。また、衛生面も作業者の健康に間接的に影響を与えるではないかと考えられる。今後、この問題を解決するためには焼却炉を建設だけでなく、衛生面も踏まえて、収集運搬や作業し方などの全体プロセスを見直すのが必要であると考えられる。また、KM32 最終処分場に調査した際に作業員の話から医療廃棄物を収集する作業員の 1 人が針刺されたため、まだ入院しているとの情報がある。

図 6 焼却炉視察現場

図 7 医療廃棄物下ろす作業

図 8 医療廃棄物量計測の作業

4.1.3.実態調査結果

①病院結果

各病院のヒアリング調査並びに推計を行った結果を表1、2、に示す。

表1 各病院の医療系感染性廃棄物発生量

NO	病院名	2016年医療系感染性廃棄物発生量		
		kg/年	kg/入院患者1人	kg/床*日
1	Setthathirath 病院	13091	1.032	0.163
2	Mahosot 病院	43321	2.115	0.276
3	Mittaphab 病院	26035	1.875	0.238
4	109 病院	3035	2.399	0.083
5	その他	-	1.855	-

※「その他」は研究対象以外の医療機関、クリニック、他の病院になっている。「その他」の原単位（kg/患者1人）はNo1-4のデータを平均したものである。

表1よりMahosot病院が最も多くの医療系感染性廃棄物が発生していることがわかった。一人当たりの患者はSetthathirath病院が最低い値を表している。これは、Setthathirath病院がよく医療廃棄物を分別しているではないかと考えられる。なお、入院患者一人当たりの医療廃棄物発生量は実態量であり、一般廃棄物にも本来ならば医療廃棄物として分別すべき廃棄物も存在していると考えられる。

各病院の基本情報を表2に示す。

表2 各位病院の病床、入院患者数および外来患者数（２０１６年のデータ）

NO	病院名	現在の院床数（床）	将来の院床数（床）	入院患者数（人）	外来患者数（人）
1	Setthathirath 病院	220	250	12687	62482
2	Mahosot 病院	430	600	20482	213263
3	Mittaphab 病院	300	508	13885	129067
4	109 病院	100	300	1265	8927
5	その他	-	-	22210	-

システムダイナミクスモデルに用いる基本データを表3に示す。出典はstatistical Year Book[2)]（ラオス統計局）およびWorld Development Indicator[1)]（世界銀行）である。

表 3 システムダイナミクスモデルに用いられるデータ

No	項目	値	単位
1	ビエンチャン都人口	860113	人
2	出生率	0.0251	-
3	死亡率	0.0065	-
4	64 歳以下人口割合	0.9570	-
5	65 歳以上人口割合	0.0423	-
6	受療率	0.0820	-
7	処理料金	10656	Kip/kg
8	レート[6)]	1 円＝70Lak	

②最終処分場結果

2017 年 3 月 10 日から 29 日にかけて最終処分場において実態調査を行った。最終処分場と契約している 25 医療機関から医療感染性廃棄物を搬入する曜日を表 4 にまとめた。

表 4 より、最終処分場には 25 医療機関が医療感染性廃棄物搬入の契約を結んでいるが、実際は 19 医療機関しか、医療系感染性廃棄物を最終処分場に搬入されていないことが分かった。19 医療機関のうちに 11 機関は毎週に搬入されているが、7 機関は時々に搬入することがわかった。また、日曜日は収集を行っていない。

表 4 医療機関から医療感染性廃棄物を収集する曜日

NO	医療機関名	収集曜日						
		月	火	水	木	金	土	日
1	Mahosot 病院	○a	○a	○a				
2	Sethathilad 病院	○e						
3	Mittaphap 病院		○i		○i			
4	109 病院			○0				
5	103 病院	○0						
6	Children`s 病院		○h		○h			
7	Mother And Child Health 病院		○o	○o	○o			
8	Xaythani 市病院				○a			
9	Maekhong クリニック			○a				
10	Thongkham クリニック	○h						
11	Hanoi Viengchan クリニック			○a				
12	献血センター					○ 血		
13	merier 研究所	時々に搬入されている						
14	pasater lao 研究所							
15	Viewmor クリニック							
16	Xaysetha 市病院							

17	アメリカ大使館	
18	Nakhoneluang Grand クリニック	
19	臨床検査科（Mahosot 病院）	
20	Sisattanak 市　病院	実際搬入されていない
21	Sikhottabong 市　病院	
22	Chanthabuly 市　病院	
23	医療リハビリテーションセンター	
24	医療検査センター（Sisattanak 市）	
25	医療センター　T2	

最終処分場の記録より 2015、2016 年の各医療機関の医療系感染性廃棄物発生量を図 9 にまとめた。

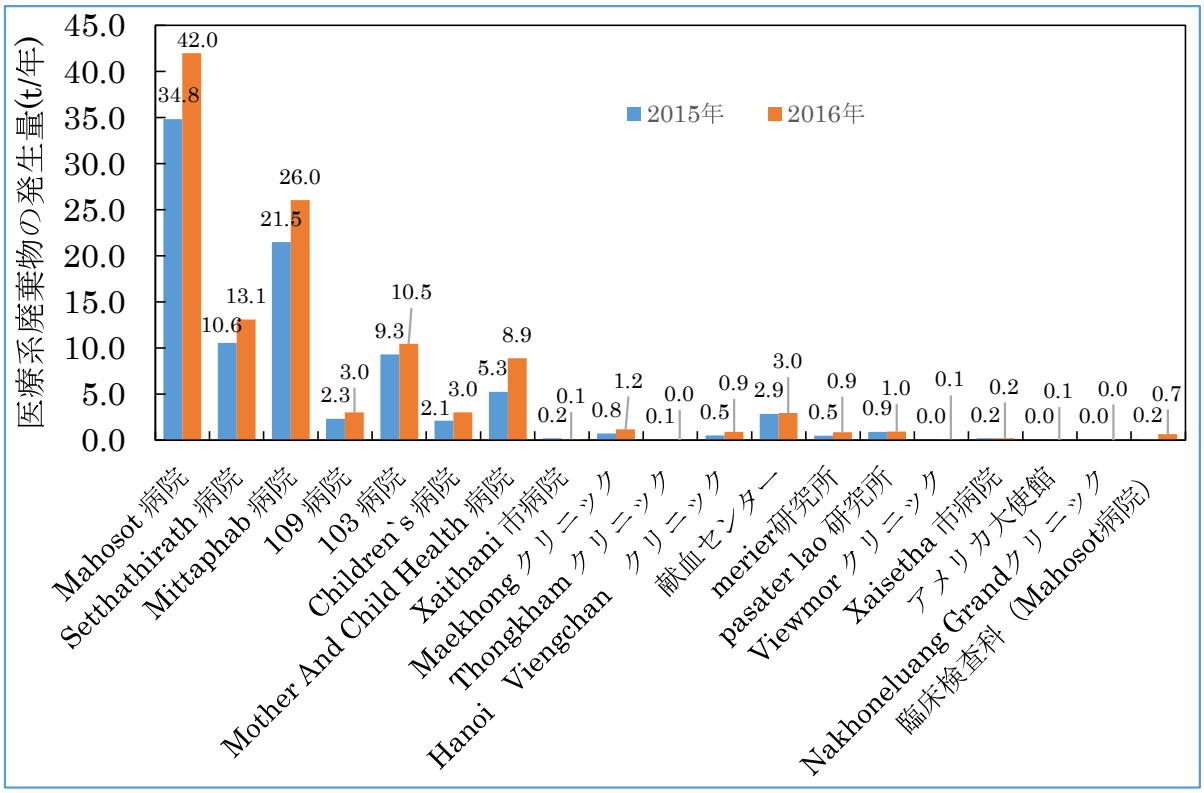

図 9　2015、2016 年の各医療機関の医療系感染性廃棄物発生量

図 9 によると全ての医療機関の医療廃棄物発生量は増加する傾向が見られるため、将来的にも増加ことが予想される。そのため、医療系感染性廃棄物問題を改善するためには将来の医療廃棄物発生量を予測することが重要であると考えられる。

また、処分場の記録を集計し、2015 年、2016 年度の各病院からの医療系感染性廃棄物を KM32 最終処分場に搬入した合計量をまとめたものを図 10 に示す。

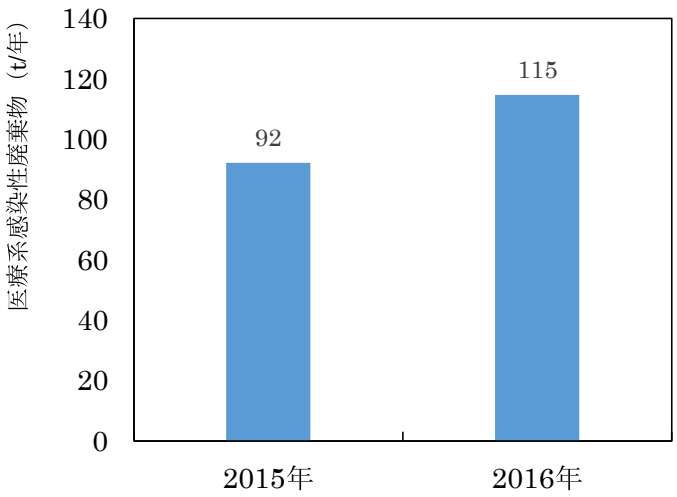

図 10 KM32 最終処分場に搬入された医療系感染性廃棄物量

また、2017 年 3 月 10 日から２９日にかけて、KM32 処分場で医療系感染性廃棄物の搬入量と焼却を計測した。計測結果を図 11 に示す。

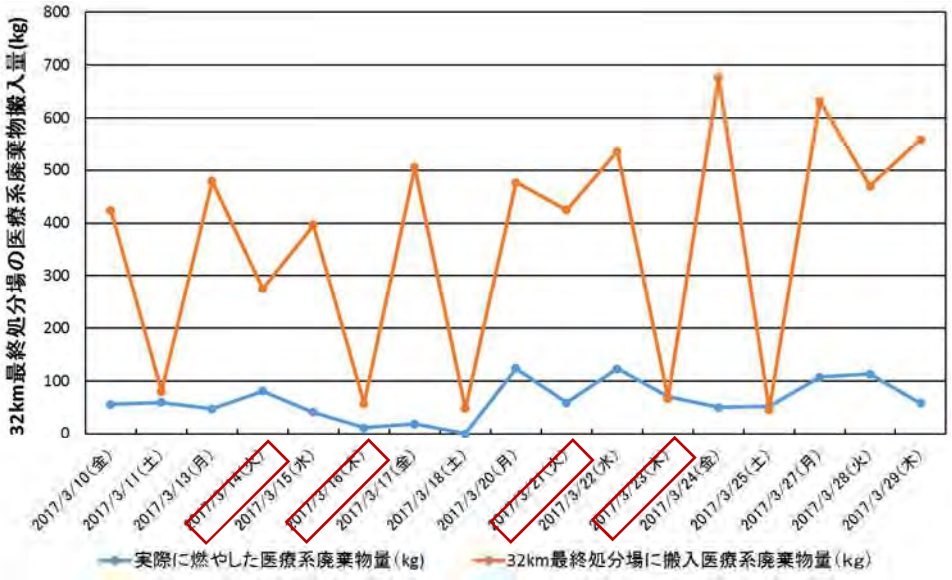

図 11 医療系感染性廃棄物量計測結果

図 11 によると KM32 最終処分場に搬入された医療廃棄物量は日によって大きく異なることが分かる。1 日平均すと 361.94kg/日でした。しかし、実際に燃やした量の平均 66.81kg/day であった。それで、搬入された医療廃棄物量に対しては医療廃棄物約 18.45%しか燃やさなかったことが本調査で明らかになった。この結果から医療系感染性廃棄物を処理するために現在の焼却炉より大きな処理能力の焼却炉を建設することが必要だといえる。

4.2. システムダイナミックスモデルによるラオス国ビエンチャンの医療廃棄物発生量将来予測

4.2.1. システムダイナミックスによるラオス国ビエンチャンの医療廃棄物発生量将来予測モデルの概要

システムダイナミクスとは予測の対象となる変数に対して時間というコンセプトを使って、その変数が「どのような働きを示す」「どのように変化していくのか」を簡単に追跡できるツールを提供するものである。[28)]

本モデルはシステムダイナミックスの概念を用いて医療廃棄物発生量の推計を予測するモデルの構築を行った。医療廃棄物量推計の手順は次に示すとおりである。

本モデルでは将来の医療廃棄物発生量に影響を与える要因として人口の増加と病床の増加を考慮した。入院患者と診察患者の比率はどの病院でも大きな変化はないと仮定し、各病院の入院患者数によって、各病院に割り当てられるビエンチャン都の人口（人口範囲）を推計した。それぞれの人口範囲の増加に基づいて各病院から発生する医療廃棄物量を推計した。

人口の増加はラオス国統計から、病床数の増加はヒアリング調査から引用した。

なお、各病院の入院患者数によって、各病院に割り当てられるビエンチャン都の人口（人口範囲）を推計したのは次の仮定に基づく。病院には入院患者と診察患者がいるが、病院の記録では診察部門からの廃棄物は発生していない。現実には診察時に受けた検査によって廃棄物発生していると考えられるが、その廃棄物は検査部門からの発生として計上されていると推測できる。しかしながら、検査部門は診察部門と入院部門の両方の検査を扱うので、検査部門からの廃棄物を診察部門と入院部門と入院部門に分けることはできない。そこで、し、入院患者数で病院全体の医療廃棄物発生量を予測した。

各病院を利用すると予測される人口範囲
↓
各病院の人口範囲における 65 歳以上と 65 歳以下の人口
↓
各病院の人口範囲における 65 歳以上と 65 歳以下の患者数
↓
各病院の患者数の合計
↓　　←患者一人当たりの医療系感染性廃棄物の発生源単位
各病院の医療系感染性廃棄物の発生量

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[28]土金達男、シミュレーションによるシステムダイナミクス入門、p21～22、2005

4.2.2.　医療廃棄物発生予測モデルの概要

実態調査データを用いたラオス国ビエンチャンの医療廃棄物発生量将来予測モデルを作成し、図 12 に示す。また、 図 12 中の図形の説明を表 5 に示す。

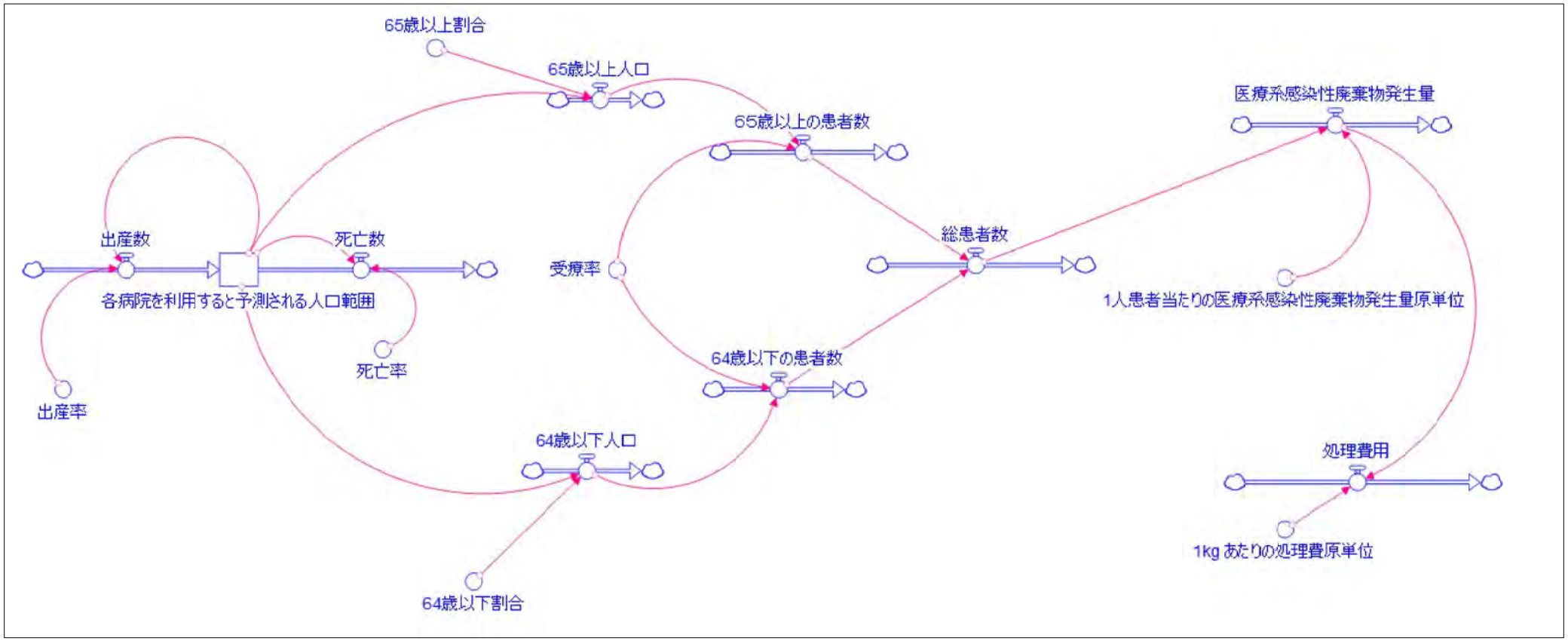


図 12 システムダイナミックスモデル

表 5 図形の説明

図形	説明
	フロー:時間帯における変数の流れ
	ストック:ある時点における変数の量
	コンバーター:フローの大きさに影響を与える因子
	コネクタ:フローとコンバーター、もしくはストックを結び付け、関係性を表す

4.2.3.　各病院を利用すると予測される人口の計算

① 各病院に入院割合

各病院の入院率（ビエンチャン都の全入院患者数のうち各病院に入院している人の割合）を式(1)に示す。

$$d_i = \frac{c_i}{a \times b} \qquad (1)$$

a: ビエンチャン都人口　　b: 受療率

c_i:入院患者数　　d_i: 各病院の入院率

i=1:Setthathilad 病院　2:Mahosod 病院　3:Mittaphap 病院　4:109 病院　5:その他

② 各病院を利用すると予測される人口（病床変化なしの時）

各病院を利用すると予測される人口（病床変化なしの時）を式(2)に示す。

$$e_i = \mathrm{a} \times d_i \qquad (2)$$

e_i: 各病院を利用すると予測される人口範囲（人）（病床変化なしの場合）

③ 各病院を利用すると予測される人口（病床が変化ありの時）

各病院を利用すると予測される人口（(病床が変化ありの時）は以下の式(3)に算出した。

$$f_i = e_i \times \frac{h_i}{g_i} \qquad (3)$$

f_i: 各病院を利用すると予測される人口範囲（人）（病床が変化ありの場合）

g_i: 現状の病床数

h_i: 各病院の増床計画に基づいた病床数

以上に基づき、各病院に入院率および各病院を利用すると予測される人口範囲の結果を表 6 に示す。

表 6　各病院に入院率および各病院を利用すると予測される人口範囲

No	病院名	各病院に入院率	各病院を利用すると予測される人口範囲（人）（病床変化なしの時）	各病院を利用すると予測される人口範囲（人）（病床が変化ありの時）
1	Setthathilad 病院	0.18	154720	175818
2	Mahosod 病院	0.29	249780	348531
3	Mittaphap 病院	0.20	169329	286731
4	109 病院	0.02	15427	46280
5	その他	0.31	270857	270857

表 7　各病院の予定増床数

NO	病院名	現在の院床数（床）	将来の院床数（床）
1	setthathilad 病院	220	250
2	mahosod 病院	430	600
3	mittaphap 病院	300	508
4	109 病院	100	300

4.2.4.　モデルの計算式

① 各病院を利用すると予測される人口範囲[29)]

$$P(t) = P(t-1) + \big(P(t) \times BR(t)\big) - P(t) \times DR(t)) \quad (4)$$

P(t)：各病院を利用すると予測される人口範囲（人）
BR：出産数　　DR：死亡率

$$P_{64} = P(t) \times P_{64}R(t) \quad (5)$$

P_{64}：64 歳以下の人口　　$P_{64}R(t)$：64 歳以下の人口割合

$$P_{65} = P(t) \times P_{65}R(t) \quad (6)$$

P_{65}：65 歳以下の人口　　$P_{65}R(t)$：65 歳以下の人口割合

② 患者数

・64 歳以下の患者数

$$Pt_{64} = P_{64} \times MeR \quad (7)$$

29並木佳純、日本の医療系廃棄物・福祉系廃棄物発生量予測に関するシステムダイナミックスモデル開発、修士論文、pp50～51、2011

Pt_{64}：64 歳以下の患者数　　・MeR：受療率

・65 歳以上の患者数

$$\mathrm{Pt_{65}} = \mathrm{P_{65}} \times \mathrm{MeR} \qquad (8)$$

Pt_{65}：65 歳以上の患者数　　・MeR：受療率

・総合患者数

$$\mathrm{Pt} = Pt_{64} + Pt_{65} \qquad (9)$$

P:総合患者数

③ 医療系感染性廃棄物の発生量

$$HIW_i = \mathrm{Pt} \times \mathrm{HIWRi} \qquad (10)$$

HIW_i:医療系感染性廃棄物（kg/年）
i=1:Setthathilad 病院　2:Mahosod 病院　3:Mittaphap 病院　4:109 病院　5:その他
$HIWR_i$:患者 1 人あたりの感染性廃棄物発生量の原単位（kg/人）

④ 処理費用

$$\mathrm{PC} = HIW_i \times \mathrm{PCR} \qquad (11)$$

・PC:　処理費（kip）　　・PCR:　処理費原単位（kg/人）

4.2.5.システムダイナミックスモデルによりシミュレーション

ラオスの医療廃棄物に関するシナリオを設定し、シミュレーションを行い、ラオス国ビエンチャン都の医療系感染性廃棄物発生量将来予測を行った。

まずは表 2 に示すようにラオスの病院の増床計画を入れたシナリオを検討した。

また、廃棄物の排出原単位に関するシナリオも検討した。病院から排出される一般廃棄物の中の感染性のものを医療廃棄物として分別した場合、どの程度医療廃棄物が増えるかは一般廃棄物の中身を調査していないので不明であるが、服部ら[6]によると調査した日本の病院から排出される医療廃棄物排出量を換算すると 0.553（kg/bed/day)になる。表 1 によるとラオスの病院では 0.083~0.276（kg/bed/day)であることから、ラオスでの分別が日本並みになったとしたら医療廃棄物の２倍は排出されるとよそされる。このことから医療廃棄物の排出原単位が２倍になったとしたシナリオも設定した。

	一般廃棄物の中から感染性廃棄を分別せず	一般廃棄物の中から感染性廃棄を分別
病床数の変化なし	シナリオ１	シナリオ３
病床数が増加	シナリオ２	シナリオ４

5. システムダイナミックスモデルによるシミュレーション結果

5.1. 医療系感染性廃棄物発生量結果

ビエンチャン都の医療系感染性廃棄物発生量のシステムダイナミックスモデルによるシミュレーション結果を図 13 示す。なお、増床の時期は明らかでないので、2016 年から増加しているとした図を載せた。

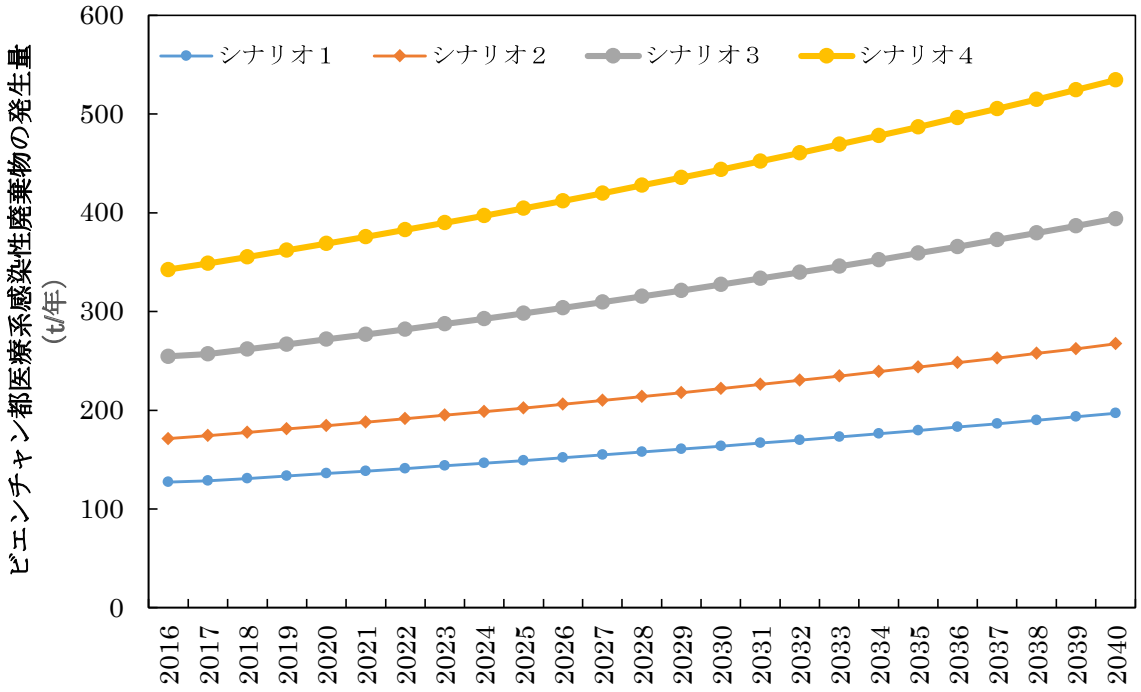


図 13 ビエンチャン都の医療系感染性廃棄物発生量

図 13 よると、すべてのシナリオで、人口の増加に伴って医療系感染性廃棄物発生量が年々増加している。シナリオ 2、4 において、各病院の計画にそれぞれ病院に新病棟を建設したり、拡大したりすることがあるので、病床数が増える。そのため、医療系感染性廃棄物発生量が大きくなる。また、2020 年の時点を見ると、シナリオ 1、2、3、4 はそれぞれ医療廃棄物発生量は 136（t/年)、184（t/年)、271（t/年)、368（t/年）である。 1 日あたりに換算するとシナリオ 1、2 はそれぞれ医療廃棄物発生量は 373（kg/日)、505(kg/日）、646（kg/日)、1010(kg/日)であることが明らかになった。

そのため、全てのビエンチャン都の医療系感染性廃棄物処理を可能とするためには以下の表 6 ように焼却炉を建設べきだと考えられる。焼却炉の耐用年数は 20 年 [5] と仮定する。

表 6 ビエンチャン都の医療系感染性廃棄物の発生量(kg/日)

シナリオ名	ビエンチャン都の医療系感染性廃棄物の発生量(kg/日)		建設するべきの処理能力の大きさ（kg/日）
	2020 年	2040 年	
シナリオ 1	373	540	600

シナリオ 2	505	732	800
シナリオ 3	746	1080	1100
シナリオ 4	1010	1464	1500

排出原単位が現状で、各病院が計画した通りに病床数が増加する場合はビエンチャン都の全ての医療系感染性廃棄物量を処理可能ためには 800（Kg/日）の処理能力の焼却炉を建設することが必要だと考えられる。

また、シナリオ 1、シナリオ 2 の 2020 年度の各病院の医療系感染性廃棄物発生量の結果を図 14 示す。（シナリオ 3、4 は倍となるので略）

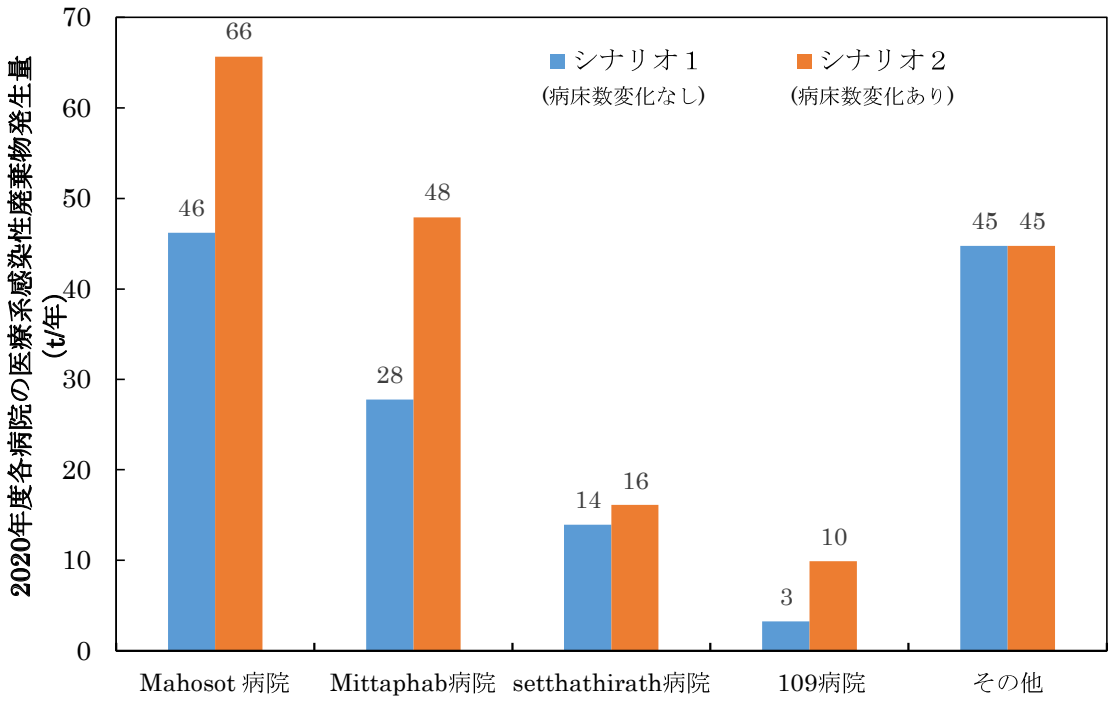


図 14 2020 年度の各病院の医療系感染性廃棄物発生量

図 14 により、Mahosot 病院と Mittaphab 病院は病床数を増やす計画があるため、各病院を利用すると予測される人口範囲も増加することから両病院は最も医療系感染性廃棄物発生量が増加することがわかった。

なお、本モデルによる結果の検証のため、シミュレーション結果値と処分場のデータに基づいた値を比較し図 15 に示す。両者を比較すると計算値と実測値はほぼ等しいといえる。計算値が病院での調査から得られた排出量原単位を利用している一方で、実測値は処分場のデータであり、両者のデータソースは異なることから、本モデルの確からしさが検証されたといえよう。

しかしながら、その他においては計算が実測値より大きいことがわかった。この理由として、計算値はビエンチャン都の全体の人口に対してを計算した。一方で、実際はビエンチャン都の医療系感染性廃棄物量はまだ、全て収集できていないため、実測値が計算値より小さいである。

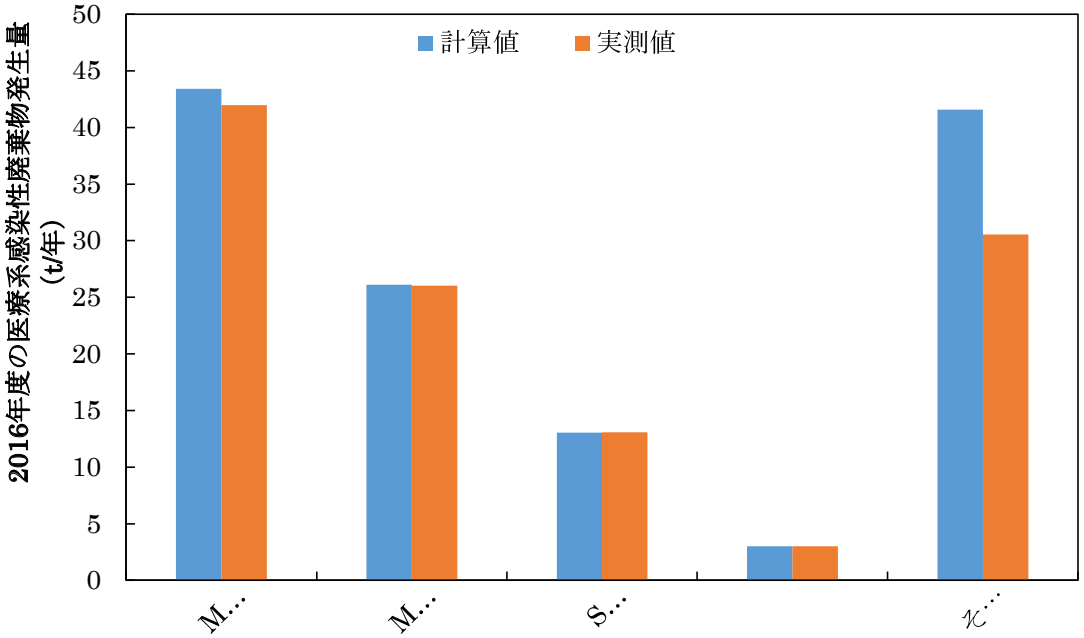


図 15 2016 年度の各病院の医療系感染性廃棄物発生量の計算結果と実測値の比較

（別添 3）分別表

■มาดตะถานในภานแยกขี้เหยื้อติดเชื้อ

平成25年1月20日作成

ลายละอยด	ใช้	พาสะบะใส่
ขี้เหยื้อติดเชื้อ		
เข้ม	使用・未使用問わず	 40Ｌ感染性専用容器 ※容器フタに 「お客様施設名」 を必ずご記入下さい
มีดตัดถัดเต้		
เข้มสัมายๆ		
ขลอดใส่เหลือ ขลอดหีดลอยๆ		
จาน		
Cover glass		
ห่ำปัดสะหวะ		
ชุดสะโลม		
ชุดป่งนเลือด		
Dialyzer		
สายห่ำแต่ละชะนิด		
ถังสะโลม		
ขลอดยาๆ		
จอกใส่น้ำปัดสะอะ		
ผ้าแผ		
ผีม		
แพมเผ็ด		
その他感染性と認められるもの	要確認	
ขี้เหยื้อบ่ติดเชื้อ		
ขี้เหยื้อปาพลาสติา		 45Ｌ非感染性専用段ボール箱
กอดน้ำยา ปาลาสติา	内容物なきこと	
แก้วน้ำยา (เป่า)	内容物なきこと	
ไม้ผันขี้ขู	未使用に限る	
เจ้ยหมั่นตลา		
Mouthpiece		
ถังมี		
พาสะบะพาลาสุะติา	内容物なきこと	
แผงยา	内容物なきこと	
อุปะกอบเจ้ยหั่วไป	未使用に限る	
ขี้เหยื้อโลหะ		
ฝาพาสะบะ	付着物なきこと	

ພາສະນະເຫລັກ	内容物なきこと	※段ボールフタ部分に 「お客様施設名」 「種類：プラスチックゴミ 金属ごみ ガラス陶磁器ごみ を必ずご記入下さい
ຟິມ x-lay		
ນອດ		
ຂີເຫຍື່ອແກ້ວ		
ແກວສະໂລມ（洗浄必須）	キャップ・付属物を取り除き、瓶の色ごとに選別・廃棄	
ແກວນ້ຳກັນ		
ແກວຢາ		
ຂີເຫຍ້ອຈາກX-ray (ອາຊິດ ດ່າງ)		 10Ｌ廃液用専用容器 ※容器横に「お客様施設名」 を必ずご記入下さい
ອາຊິດ	pH 2.1以上	
ດ່າງ	pH12.4以下	
要確認・お見積もり		
ຂີ້ເຫຍື້ອຕິດໄຟ	シンナー・キシレンなど	ກຳນົດຫຼັງຈາກທີ່ປະຊຸມ
ອຸປະກອນການທົດສອບທາງການແພດ	診察台・机など	
ຢາທີ່ຍັງບໍ່ໄດ້ໃຊ້	ブドウ糖・栄養剤など	
お引き取りできないもの		
ທາດທີ່ເປັນພິດ	砒素・硫酸を含むものなど	ກຳນົດຫຼັງຈາກທີ່ປະຊຸມ
formalin	検体保管など	
Lead products	検査用エプロンなど	
product using PCB	器具の電源など	

（別添４）　焼却炉仕様書

Specification

chuwastar

Model: CX-3

Manufacturer : CHUWA INDUSTRIAL CO., LTD.
8-7, Nihonbashihontyou 2-chome, Chuo-ku, Tokyo
Tel : +81 3 5643-2571
Fax : +81 3 5643-2572

							提　出	1
							返却用	0
1	H. matsumoto	2017/6/15	—	—			中和機工 営業	1
							中和機工 生産技	0
							中和機工 ﾌﾟﾗﾝﾄ	0
REV	作　成	日　付	審　査	日　付	承　認	日　付	中和機工 工事部	0
							合　計	2

CHUWA INDUSTRIAL CO., LTD
中　和　機　工　株　式　会　社

部　署	工事番号	文書番号（仕様書又は図面番号）	REV	出　図　日
営業技術部	48M17165	21AS0001	1	2017/6/15

<SPEC.>

ANTI POLLUTION SMOKELESS INCINERATOR

1 Type of Incinerator

Name:	CHUWASTAR	
Type:	CX-3	
Capacity:	80	kg/h
Running time:	6	hr/day
Sort of waste:	Medical Waste,Plastics,Waste oil	

2 Criterion of Design

Smoke density:

When ignited:	0～1.5	
Normal combustion:	0～0.5	
When finished:	0～1.5	

Dust density

Less than:	0.15	g/Nm^3

Combustion temperature

Primary combusiton:	800	～	1,000 ℃
Second combusiton:	1,050	～	1,200 ℃

3 Design calculated value about the pollutant

NO.	Parameter	The standard value	
1	Dust	150	mg/Nm^3
2	HCl	–	mg/Nm^3
3	CO	–	mg/Nm^3
4	SO_2	–	mg/Nm^3
5	NO_X	–	mg/Nm^3
6	Hg, Compound	–	mg/Nm^3
7	Cd, Compound	–	mg/Nm^3
8	Pb, Compound	–	mg/Nm^3
9	PCDD/PSDF	–	$ngTEQ/Nm^3$

4 Specification

(A) Model of Incinerator

Combustion capacity:	80	kg/h
Hearth:	1.72	m^2
Furnace capacity:	2.23	m^3
Material		
Inside wall:	SS400	9.0 mm
Outside wall:	SS400	4.5 mm
Firebed:	Cement castable	t=100mm
Net weight:	2,280	kg
Water jacket capacity:	2,000	L
Working weight:	4,280	kg
Vapourised water volume:	190	L/hr

*It is the numerical value of after 45 minutes from ignition

(B) Blower(High pressure turbo fan)

Type:	TFM-550SSL	
Air volume:	50	m^3/min(MAX)
Air pressure:	5.3	kPa(MAX)
Revolution:	2900	rpm
Source:	AC 200V	
Output:	5.5	kw 2P 3Φ
Quantity:	1	set
Weight:	89	kg
Manufacture:	OLYMPIA KOGYO Co., Ltd	

(C) Ignite Burner

Type:	LT-3V
Fuel:	Kerosin
Nozzle tip size:	2.5 gallon/hr
Fuel Consumption :	9.5 L/hr
Contorol Mode:	ON-OFF
Source:	AC 200V
Output:	0.15 kw 2P 3Φ
Quantity:	1 set
Weight:	15 kg
Manufacture:	OLYMPIA KOGYO Co., Ltd

(D) Secondary Combustion Chamber

Material:	SS-400 4.5 mm ALUMINIZED
Dimension:	Φ600 × 1,700 mm
Capacity:	0.8 m^3
Quantity:	1 set
Weight:	195 kg

(E) After Burner

Type:	LT-20V
Fuel:	Kerosin
Nozzle tip size:	4.0 gallon/hr
Fuel Consumption ratel:	15.1 L/hr
Contorol Mode:	ON-OFF
Source:	AC 200V
Output:	0.25 kw 2P
Quantity:	1 set
Weight:	20 kg
Manufacture:	OLYMPIA KOGYO Co., Ltd

(F) Oil Tank

Type:	KS2-200SC
Material:	Zinked steel t=1.6mm
Capacity:	198 L
Oil Outlet size:	φ27.2 mm
Quantity:	1 set
Weight:	41 kg
Manufacture:	SUNDAI Corporation

(G) Dust Collector (cyclon)

Type:	Herical Top
Material:	SS400 4.5 mm ALUMINIZED
Dimension:	Φ1,000 × 3,650 mm
Quantity:	1 set
Weight:	1,300 kg
Accessory:	Dust Box、Support Frame

(H) Neutralizing reaction device

Device

Type:	CHUPROCE-450
Material:	SS400 ALUMINIZED
Size:	550 × 610 × 840H
Quantity:	1 set
Weight:	60 kg

PyroScreen

Material:	SUS316 t=0.5mm
Size:	450 × 680 mm
Quantity:	4 pieces
Manufacture:	NUNOBIKI SEISAKUSYO

Electromagnetic pump

Type:	VN2GNXW
Flow quantity :	18.0 L/hr
Pressure:	1.0 MPa
Control Mode:	ON-OFF
Source:	AC 200V
Output:	0.033 kw 2P
Quantity:	1 set
Weight:	0.9 kg
Manufacture:	Nippon Control Kogyo Co., Ltd

Solution tank

Material:	Plastics PE
Volume:	25 L
Quantity:	1 set
Accessories	Control Valve

Spray nozzle

Consumption ratel	0.5 Gallon/H
Material	SUS304
Quantity	2 sets

Air cooling device for spray nozzle

Location	Chuproce's nozzle socket--Ejector pipe
Size	10A × 500L
Material	SUS Flexiblle tube
Quantity	1 set

Accessories

Goggles	
Quantity	1 set
Rubber gloves	
Quantity	1 Box

(I) Chimny

Material:	SS400 ALUMINIZED
Size:	ϕ450 × 1,500 mm
Quantity:	3 set
Weight:	250 kg
Accessory:	

(J) Steam Exhaust Duct

Material:	SS400 4.5 mm
Size:	Φ600 × 1,700 mm
Quantity:	1 set
Weight:	146 kg

(K) Water Supply Tank

Material:	SS400 3.2 mm
Size:	550 × 550 × 800^{H} mm
Quantity:	1 set
Weight:	55 kg
Accessory:	Electrodes, Ball Tap, Water Level Gauge

(L) Warning Buzzer Unit of Water Level

Type:	Electrode Bipolar System
Manufacture:	TATEISI ELECTRIC CO.,LTD
Quantity:	1 set

(M) Water Level Control Unit

Type:	Ball cock floating
Quantity:	1 set

(N) Temperature Sensor (Thermo couple)

Class:	K
Size:	φ22 × 900 mm
Material:	SUS310S
Quantity:	1 set
Manufacture:	SOKKIKI Co.,LTD.

(O) Temperature Controllers

Type:	TTM-04SP
Input Type	K
Range(℃)	-210 ～ 1,382 ℃
Quantity:	1 set
Manufacture:	TOHO Electronics Inc.

(P) Control Panel

Type:	Outdoor type
	including: Warning buzzer, Control tim
Quantity:	1 set

(Q) Tranceformer

Transform:	P-380V ⇒ S-200V
Capacity:	5 KVA
Weight:	2 kg
Quantity:	1 set

(R) Waste Oil Tank

Material:	SS400 3.2 mm
Size:	300 × 500 × 500^{H} mm
Quantity:	1 set
Weight:	55 kg
Accessory:	

(S) Main Dimention

Height:	8,950 mm
Waste Inlet:	700w × 600H mm
Ash Outlet:	500w × 600H mm

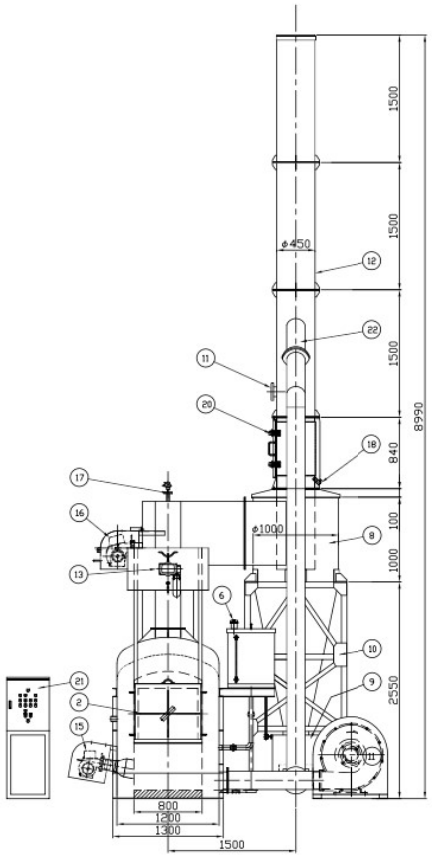
(T) Dimention of Piping

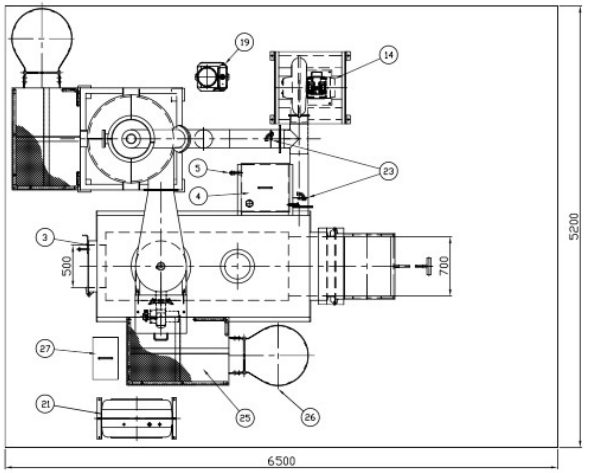
Primary Water Supply:	φ27.2 mm	20 A
Drain of Main Body:	φ48.6 mm	40 A
Outlet of Hot Water:	φ60.5 mm	50 A
Oil Pipe:	φ13.8 mm	8 A

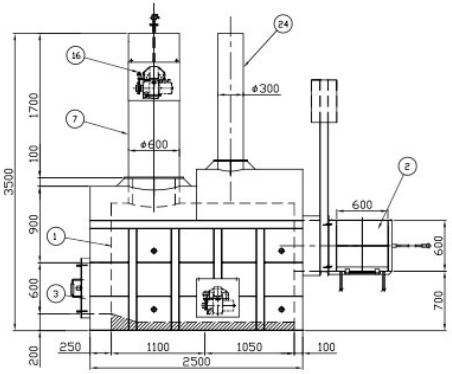
(U) Painting: Silver Top Heat Proof

(V) Accessory:

Iron Bar for Treating Ash:	1 set
Iron Bar for Scrambling Ash:	1 set







NO.	DESCRIPTION	MAT'L	QTY'S	DWG. NO. REMARK
29				
28				
27	WASTE OIL TANK	SS400		
26	LADDER	SS400		
25	STAGE	SS400		
24	STEAM PIPE	SS400		
23	DAMPER			
22	EJECTOR PIPE	20GA		
21	CONTROL PANEL			
20	CHUPROCH	EFFLUENTGAS PROCESING EQUIPMENT		
19	SOLUTION TANK			
18	SPRAY NOZZLE			
17	TEMPERATURE SENSOR	CA		
16	AFTER BURNER	3, φ220V, 0.25kw, LT-20V		
15	IGNITE BURNER1	3, φ220V, 0.15kw, LT-3V		
14	BLOWER	3, φ380V, 5.5kw		
13	WINCH	3, φ200V, 0.25kw		
12	EXHAUST DUCT	SS400 ALUMINIZED		
11	GAS SAMPLING HOLL	100A, JIS-5kgFF		
10	SUPPORT OF CYCLONE	SS400		
9	DUST BOX	SS400 ALUMINIZED		
8	DUST COLLECTOR(CYCLONE)	SS400 ALUMINIZED		
7	DUCT CONNECTION	SS400 ALUMINIZED		
6	LEVEL SENSOR			
5	WATER SUPPLY CONNECTION	20A		
4	FEED WATER TANK			
3	ASH OUTLET	500×400		
2	WASTE INLET	650×550		
1	INCINERATER	SS400		

承認 APP.	松本	担当 CHK.	Y. A	製図 DWG.	H. U	日付 DATE	H29. 06. 15	改正 REV.	0	客先 FOR	
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Lao People's Democratic Republic

Feasibility Survey for Improvement of Medical and Other Hazardous Waste Management in Vientiane City

Final Report Summary

September, 2017

Japan International Cooperation Agency

Kayama Kogyo Co., Ltd.

CHAPTER 1: CURRENT SITUATION IN LAOS

1-1 Political, Social and Economic Situation of Laos

At the 8th Congress of the Lao People's Revolutionary Party in 2006, policy that graduation from the Least Developed Country (LDC) category shall be achieved by 2020 was presented, and subsequently the continuation of the policy and development plans until 2030 was approved at 10th Congress of the Lao People's Revolutionary Party in 2016. While Laos is developing rapidly, GDP (nominal) per capital is still approximately $1,700. It is one of the poorest countries in Asia and it is one out of eight Asian countries that are designated as LDC by the United Nations.

Landlocked countries tend to be LDC. It is because transport costs to neighboring countries are high. With the support of Japan and Asia Development Bank, road systems such as the East-West Economic Corridor and South-North Economic Corridor has been developed. Also, a bridge that connects Laos and Thai (the biggest trade partner) was constructed. With the improvement of logistics infrastructure, there is a significant trend for companies to allocate production centers in Laos since labor cost is cheaper than in neighboring countries. In addition, Lao People's Democratic Republic approved 12 SEZ (Special Economic Zone) nationwide to attract more foreign investment. In Vientiane city, VITA Park SEZ exists and PAKSE-JAPAN SME SEZ exists in Pakse city. Lao People's Democratic Republic plans to establish 25 SEZ and create 50,000 jobs by 2020.

1-2 Development Issues of the Target Sector in Laos

Waste generation in Laos is increasing in line with rapid economic and population growth. In the capital city of Vientiane, a medical waste incinerator was installed at the KM32 final landfill site under the LPPE program to improve the management of medical waste. However, according to the LPPE final report, the amount of medical waste brought in to the landfill is considerably higher than the maximum incineration capacity and hence a large portion of the medical waste is currently being landfilled without proper detoxification treatment. Also, the national guidelines for infectious disease prevention and management require proper segregation of medical waste at hospitals but these guidelines are not being strictly enforced, resulting in increase of general waste being treated as medical waste and medical waste being mixed with general waste and hence causing improper treatment at landfills. Furthermore, the generation of other hazardous waste such as oil and chemical waste is increasing due to increased industrial activities.

Although medical waste accounts for small amount of all the waste, there are some issues such as secondary infection and diffusion of hazardous materials. While the implementation of LPPE has improved the treatment of medical waste, there are still some issues to address. According to the LPPE final report, the amount of medical waste brought in to the landfill is considerably higher than the maximum incineration capacity and hence a large portion of the medical waste is currently being landfilled without proper detoxification treatment. Also, the national guidelines for infectious disease prevention and management require proper segregation of medical waste at hospitals. However, there are some hospitals which do not segregate medical waste properly and cleaning staffs mix segregated medical waste with general waste due to their lack of understanding. These problems result in increase of general waste being treated as medical waste and medical waste being mixed with general waste and hence causing improper treatment at landfills. According to Ministry of Health, there is also an issue that wastes are mixed during transport even though they are segregated at hospitals. The following table indicates remaining issues after the implementation of LPPE.

Process	Before LPPE	After LPPE	Remaining Issues
Waste generation	A system to segregate infectious medical waste and general waste existed but was not properly implemented at hospitals.	Training, monitoring and promotion of medical waste management conducted by MOH, VUDAA, DOH, DONRE resulted in improved awareness of medical staff.	**Non-medical staff (cleaners) not following segregation procedures, resulting in all waste becoming mixed again. Decreased motivation of medical staff.**
Collection and transport	No regulation for waste collection fees, cases of medical waste being mixed and disposed with general waste for very low fees.	Medical waste specific collection from 7 major hospitals and 6 medical facilities. Collection and incineration fees charged by VUDAA set at 10,656kip/kg	**Although LPPE proved effective, it also resulted in increased medical waste collection of 6tons/month, exceeding incineration capacity.**
Intermediate processing	No intermediate processing facility such as incinerators specifically for medical waste.	A new medical waste incinerator commenced operations at KM32 final landfill site.	**Proper incineration cannot be achieved since the amount of medical waste (around 200kg/day) significantly exceeds maximum capacity (76kg/day)**
Final disposal	Although a medical waste specific pit existed at KM32 final landfill site, mixed general waste was dumped in the pit.		**4tons/month which is over the capacity is incinerated, but still 2tons/month needs to be landfilled without any treatment.**

1-3 Development Plans, Other Relevant Plans, Policies (Including Foreign Investment Policies), and Legislative System of the Target Sector in Laos

Title	Overview
The Agreement on Waste Management of Industrial Factories by Minister of Industry and Commerce (No 0555)	General rules regarding industrial waste.
MINISTERIAL INSTRUCTIONS ON HAZARDOUS WASTE MANAGEMENT	The first regulation on final treatment and disposal of solid waste.
Industrial Waste Discharge Regulation[30](1994)	Several rules about industrial waste enacted by Ministry of Industry-Handicrafts.
Environmental Protection Law (1999), Revised Version of Environmental Protection Law(2012)[31]	General rules about management and treatment of waste. Hazardous waste is mentioned in Article 39.
Regulation on Environmental Assessment(1770/STEA)	Procedures for evaluating environmental impact, enacted in 2000.
The Decree on Environmental Impact Assessment (N0.112/PM)	The provision of evaluating environmental impact for various enterprises consisting of 42 articles, enacted in 2010.
The Agreement on Preliminary Environmental Assessment and List of Enterprises that Require Environmenal Assessment (No.697/PMO.WREA)	The list which stipulates whether IEE or EIA is required by type of enterprise, enacted by Ministry of Natural Resources and Environment in 2010.
Water Resources and Environment Administration (No2734/PMO)	Waste water regulation based on Lao National Environment Standard enacted in 2009.

30 http://faolex.fao.org/docs/pdf/lao17659.pdf
31 http://www.ilp.gov.la/Lao_Law/Environment_Law.pdf

The Ministerial Agreement on Exhaust Standards (No2062/MCI)	Exhaust regulation based on Lao National Environment Standard enacted in 2009.
Law on the Management of Chemical Substances[32]	Lao Chemical Management Law enacted in March 2017.
Revised Environment Standard	Ministry of Natural Resources revised the 2009 version of Environment Standard in March 2017.

1-4 Analysis of Precedents of ODA Projects and Other Donors regarding the Target Sector in Laos

The Table below lists precedents of ODA projects and other donors regarding the target sector in Laos.

Donor	Overview
Asia Development Bank/ The Norwegian Agency for Development Cooperation/ United Nations Development Programme (1997)	Second Provincial Urban Development Project (Technical assistance: support for urban development plan including improvement of waste treatment industry) $5,892,000
Asia Development Bank(2008～2010)	Small Scale Urban Development Project (Technical assistance: support for urban development plan including improvement of waste treatment industry) $1,276,000
Asia Development Bank/ Agency Françoise de Development (1997～2006)	Urban Infrastructure and Service Business in Vientiane City(VUISP) (Technical assistance: support for urban development plan including improvement of waste treatment industry) $8,000,000
Asia Development Bank (2004～2007)	Improvement of Solid Waste Management in Vientiane City and Income Improvement (Technical assistance: improvement of sanitary conditions through progress in waste collection/transport/treatment service in impoverished areas)
Korea International Cooperation Agency (at present)	A plan to construct an industrial waste treatment facility (1.5 hectare of landfill treatment). Ministry of Planning and Investment is requesting budget for the project ($5,500,000) to Government of South Korea.
ODA Project (Type)	Overview
Grant Aid	Improvement of the Solid Waste Management System in Vientiane Urban Area(1996)
Technical Cooperation Project	Project for Urban Development Master Plan Study in Vientiane Capital (2010～2017), Urban Development Management Project (2013~2017) Counterpart: Public Works and Transport Institute

[32] http://www.laotradeportal.gov.la/index.php?r=site%2Fdisplay&id=118

Grant Aid	The Project for Improvement of Solid Waste Management in Environmentally Sustainable Cities (2014)
Technical Cooperation Project	Laos Pilot Program for Narrowing the Development Gap towards ASEAN Integration (Environment component) (2011～2015) Counterpart: Ministry of Planning and Investment
Grass-Roots Technical Cooperation Project (Regional Proposal Model)	Project for Assistance to Develop an Effective Waste Utilization System with Citizen Cooperation in Vientiane Capital: Kyoto City authorities and Global Environment Center Foundation (2015～2018) Counterpart: Vientiane Capital Department of Natural Resources and Environment (DONRE)/ Vientiane Urban Development and Administration Authority (VUDAA)

1-5 Analysis of Business Environment in Laos

There is no investment promotion sector which is applied only to overseas companies, and investment in agriculture, industry, handicraft, service industry, processing industry is promoted overall. The Investment Promotion Law(No.14/NA) which prescribes Laos' investment policy and investment concessions was enforced on 19th of April in 2017 (It was passed through the National Assembly in November 2016 and promulgated by Executive Order on 16th of December). Although this law has been enforced, Decree and guidelines for executing the law are still being drafted and have not been publicated (as of August 2017). A detailed list of investment promotion sector is expected to be issued in the near future.

Regarding the establishment of incineration facilities, EIA (Environmental Impact Assessment) is required. ESIA (Environmental and Social Impact Assessment Department), which is part of the Ministry of Natural Resources and Environment (MNRE), determines the benchmark, procedure and conducts the assessment. According to the Ministry of Natural Resources and Environment, in general, it is required to conduct EIA when an incinerator is established. For the Verification Survey which will include the actual installation of an incinerator, EIA will not be required if stakeholders such as VUDAA and MNRE consult in advance.

Laos' taxation system consists of direct tax and indirect tax. The tax law which was enforced in May 2016 is the core of the taxation system. Direct tax consists of corporate tax, income tax, and environmental tax. Indirect tax consists of value added tax and excise tax. There is no tax treaty between Japan and Laos.

CHAPTER 2: FEASIBILITY OF THE PRODUCT/TECHNOLOGY OF THE PROPOSING COMPANY AND OVERSEAS BUSINESS EXPANSION PLAN

2-1 Characteristics of the Proposing Company and Its Products/Technologies

The proposing company operates an "integrated waste treatment system" in Japan consisting of various components such as (1)Sorting/crushing facility (2)RPF(Refuse Paper and Plastic Fuel) production plant (3)incineration/drying facility (4)rubber recycling plant (5)fluorescent lamp recycling plant, and this is the biggest feature of Kayama's technology. The focus of the Survey will be on the application of component (3) incineration / drying facility in Vientiane City and applying the proposing company's design, installation, operation, and management expertise regarding the incineration of medical and other hazardous waste.

2-2 Business Expansion of the Proposing Company

The proposing company operates in other Tokai prefectures such as Gifu, Mie and Shizuoka. However, it is difficult to expand its business because of the business model of industrial

waste management industry. Also, labor shortage in industrial waste management sector is quite serious. Especially, this issue is significantly important management issue for waste management company in provincial cities such as the proposing company. While it is expected to hire workers from overseas to continue its business, there are some obstacles such as language, skills and lack of training system for foreign workers and employment of foreigners has not progressed. Therefore, the proposing company expands its business into Asian market such as Laos where the demand for waste management is increasing rapidly. The synergy is expected to be gained by not only contributing waste treatment issues of proposed country but also by training local workers.

2-3 Contribution to Japan's Regional Economy from Overseas Business Expansion of the Proposing Company

(1) Operating in the industrial waste management / recycling industry requires the heavy use of equipment and machinery. Through the ODA project and subsequent business expansion, it is expected that Japanese companies which manufacture and provide the equipment for the proposing company's waste treatment system such as incinerators will benefit.

(2) More jobs will be created by increasing the number of staff that support the company's overseas business. Also, regional revitalization can be achieved through interaction of domestic workers with overseas workers that are invited to Japan through the proactive use of knowledge co-creation training programs.

CHAPTER 3: RESULTS OF PRODUCTS/TECHNOLOGY SURVEY AND CONSIDERATION OF ITS POTENTIAL APPLICATION

3-1 Activities to Assess the Effectiveness of the Products/Technology

The proposed product/technology was presented to administrative agencies such as Ministry of Health, Ministry of Natural Resources and Environment, Ministry of Industry and Commerce, Ministry of Public Works and Transport Communications, Ministry of Planning and Investment, and Vientiane Urban Development and Administration Authority (VUDAA). Also, interview with potential business partners such as KP Group was held. Furthermore, the proposing product was also presented to medical institutions such as Setthathirath Hospital, Police Hospital, Friendship Hospital, and Makhosi Hospital. Regarding hazardous materials, survey at Toyota Laos and interview with local recycling companies were conducted. Presentations were made on the product details based on materials prepared by the proposing company and product specifications and pricing were offered.

Through these explanations/presentations, it was confirmed that there is strong interest from these administrative agencies for the proper treatment of hazardous waste. Also, it was confirmed that medical institutions desire the promotion of proper treatment of medical waste through incineration. Furthermore, it was confirmed that KP Group, which operates various businesses in Laos, has strong interest in collaborating with the proposing company in the waste management sector.

Through discussions with the various agencies mentioned above, the current situation relevant to the proposed product and the regulations that affect the introduction of the proposed product were confirmed.

3-2 Assessment of Local Adaptability of the Products/Technologies

There is no law that bans incineration as a method for proper treatment of hazardous waste. According to Ministry of Industry and Commerce, incineration of hazardous waste has not been implemented mainly due to budget constraints. However, it was confirmed that they desire the promotion of hazardous waste treatment through incineration. Also, it was confirmed that the Ministry of Health recognizes the issue regarding the segregation of medical waste and is hoping for improvements to be made. Furthermore, according to the Ministry of Natural Resources and Environment, the regulatory system for the treatment of

hazardous waste is underdeveloped and they are eager to obtain information and advice. Also, it was confirmed that VUDAA recognizes the necessity for a new incinerator to match the increase in the number of hospitals in Vientiane City driven by economic growth. In addition, there were concerns from medical institutions regarding the improper discharge of waste water and inadequate treatment of medical waste and these institutions were hoping for the introduction of proper treatment including incineration.

3-3 Confirmation of Demand for the Products/Technologies

Administrative agencies generally were of the view that although they recognize the surmounting issues related to hazardous waste, they cannot address the problems due to the lack of equipment, manpower and technology. It was confirmed that they have strong interest in the proposed project. Also, through interviews with waste generators and potential business partners, it was found that the disposal of industrial waste is very problematic, but they are stuggling to find solutions since there are no waste treatment companies that can implement proper treatment.

3-4 Consistency between the Products/Technologies and Development Issues and Effectiveness

In Laos, demand for proper treatment of hazardous waste with a focus on medical waste is increasing. In urban areas, the private medical sector is expanding and the number of general practitioners amounts to approximately 600 and that of private clinic amounts to 222. In addition, the amount of hazardous waste including medical waste is increasing rapidly because of population growth and increase in income levels.

Currently, the small incinerator installed at KM32 landfill site in Vientiane does not have the capacity to treat the full amount of medical waste generated. If infectious waste is landfilled without the process of detoxification, it can lead to the contamination of groundwater/soil and negatively affect the environment and cause secondary infection. Also, due to inadequate hygienic management of workers collecting, transporting, and incinerating the waste, indirect heath hazards can arise as well as accidental injuries from discarded needles.

The following measures are considered to be effective in solving these issues;

①Utilize safety boxes instead of bags to prevent needle injuries and improve hygiene within hospitals.

②Treat medical infectious waste at a central location and not at individual hospitals to improve efficiency.

③Construct incinerators which have sufficient capacity based on proper estimations of the amount of waste generated.

④Increase awareness of medical infectious waste not only by introducing new incinerators but also by promoting the hygiene of medical staff and waste collection and transportation workers.

⑤Reduce the cost of waste treatment per patient by preventing the mixing of medical waste and general waste through extensive promotion of proper waste segretation at each hospital.

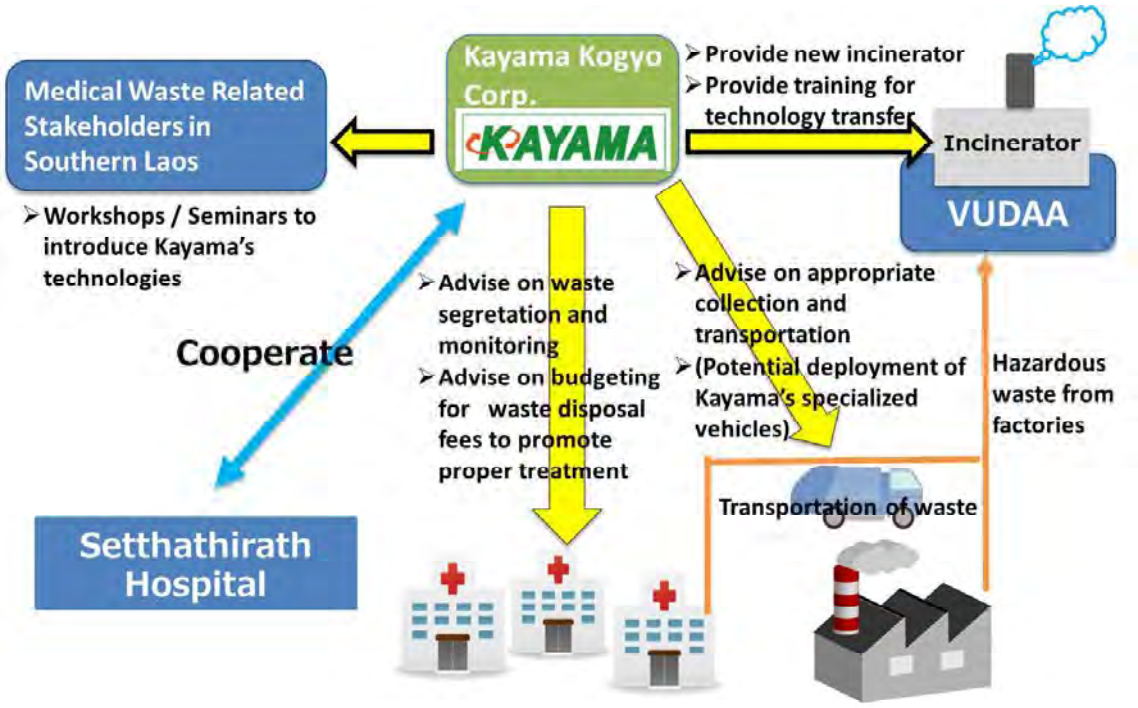
CHAPTER 4: CONCRETE PROPOSAL OF ODA PROJECT

4-1 ODA Project Overview

The proposed ODA project aims to establish a waste treatment system to achieve proper treatment of hazardous waste in Vientiane city. Furthermore, the use of incineration for treating hazardous waste as well as the proper segregation of waste by medical instituitions and hazardous waste generators will be promoted through transferring the operational technology of the proposing company. The type of ODA project envisaged is the Verification Survey scheme.

A small-scale incinerator will be installed, and safety boxes to be used for segregating medical waste will be offered to medical institutions as part of the Verification Survey. The purpose is to improve the safety and efficiency of the current waste segregation process by utilizing Japanese expertise. By providing demonstrations using the new incinerator, the goal will be to create a model for hazardous waste treatment and to disseminate the model to other areas.

VUDAA will be the local counterpart, and a state-of-the-art incinerator (small but environmentally friendly) will be provided and installed to establish a system for the proper treatment of hazardous waste. The product effectiveness will be verified through incineration testing and data analysis. Demonstrations using the incinerator will be promoted widely to central government and local agencies to create opportunities for horizontal expansion into other areas which face similar issues. KM32 final landfill site which is managed by VUDAA is the intended installation site for the incinerator. Currently, discussions with VUDAA is in progress regarding the specifications and operations of the incinerator to be installed.



4-2 Concrete Collaboration Plan and Development Impact

In the Verification Survey, it is assumed that demonstration plant will be installed at the KM32 final landfill site with VUDAA as the counterpart. Through demonstration of incineration treatment of hazardous waste, knowledge transfer to VUDAA regarding the segregation management and detoxification of hazardous waste will be achieved. Also, the product effectiveness will be verified.

Project Goal	The goal is to install a high quality incinerator and improve the safety and efficiency of the current waste treatment process by utilizing Japanese expertise. The proposing company will promote the waste segregation system conducted in Japan and aim at not only improving efficiency but also minimizing the physical and mental burden on staff and improving the work environment. Demonstrations using the incinerator will be conducted to create opportunities for horizontal expansion into other areas.
Output	Detoxification of hazardous waste will become possible. Also, proper management and detoxification of injection needles and

	waste oil will become possible. Through these achievements, the burden on landfill sites will be reduced by 90% on a volume ratio basis. (The current plans for the industrial waste treatment project at KM32 supported by the South Korean government does not include the installation of new incinerators. Therefore, there is no duplication regarding the effect of waste volume reduction and detoxification but rather a supplementary effect). A proper management model for hazardous waste treatment will be established and can be disseminated to other areas in Laos.	
Duration	24months	
Rough Estimate of Total Cost	Equipment manufacturing and purchase (transport and installation cost included)	¥38,214,000
	Travel Expenses	¥12,635,000
	Local Activities Expenses	¥3,961,000
	Training in Japan for Counterpart	¥2,328,000
	Labor cost(direct labor cost・other labor cost・management cost included)	¥28,806,000
	Management expenses	¥5,661,000
	Consumption tax (8%)	¥7,328,400
	Total	¥98,933,400

Through the implementation of the Verification Survey, the full amount of hazardous waste currently accepted at KM32 can be incinerated by the combined usage of the existing incinerator and the new incinerator. Also, waste segregation of medical waste at hospitals will be promoted. However, it should be noted that the expected future increase in hazardous waste will make it difficult to maintain full incineration.

The expected factors and development impact from the Verification Survey are as follows.

Factor	Development Impact
Acquisition of technical skills regarding hazardous waste treatment and proper equipment operation at KM32	It will become possible to incinerate the full amount of hazardous waste which is currently being landfilled. Technology transfer regarding the operation of high-tech incinerators will be achieved.
Promotion of waste segregation management in hospitals	Currently, recyclable waste such as plastic, paper, and textiles is being landfilled. Proper segregation will lead to reduced volume of waste and contribute towards extending the lifespan of the landfill site.
Development of waste segregation and collection system	Even though there is a strong demand for recycled fuel from private companies, most recyclable waste is landfilled due to lack of recycled fuel technology and weak waste segregation systems. In the future, the establishment and operation of an intermediate waste treatment facility will contribute to waste volume reduction through the conversion of waste to fuel which can be utilized by cement manufacturers and other industries. such as cement industry is promoted.

4-3 Potential for collaboration with other ODA projects

Currently, “Urban Development Management Project (2013~2017) is being implemented as an ODA project following on from the “Project for Urban Development Master Plan Study in Vientiane Capital”(2010～2011). The project aims to properly manage and induce urban development projects, develop a favorable urban environment and implement infrastructure development in an organized manner. Waste management plans are also included in this project. Although the target field is not strictly the same, this ODA project and the proposed project both support the waste management area and there is a possibility for synergetic effects such as sharing of knowledge on waste management plans / laws and regulations / statistics and data management through the establishment of good communications between the two projects.

4-4 Issues Regarding ODA Project Formulation

It is desired that discussions with relevant parties regarding the potential to utilize grant aid and technical cooperation schemes by confirming the technical advantage of the proposing company through the verification survey. Regarding implementation of the Verification Survey, discussions with VUDAA and Setthathirath hospital are ongoing regarding equipment selection and clarification of roles and responsibilities. The appropriate equipment specifications that meet budget constraints will continue to be considered.

4-5 Environmental and Social Consideration

There are mainly two points that relate to Environmental and Social Consideration.

① Construction works to install the incinerator

② Working environment of hazardous waste treatment

Regarding ①, air pollution, water pollution and noise caused by construction works are relevant. For the proposed project, the planned site is remote from any residential areas. Construction works will be conducted in accordance with the relevant legislations in Laos.

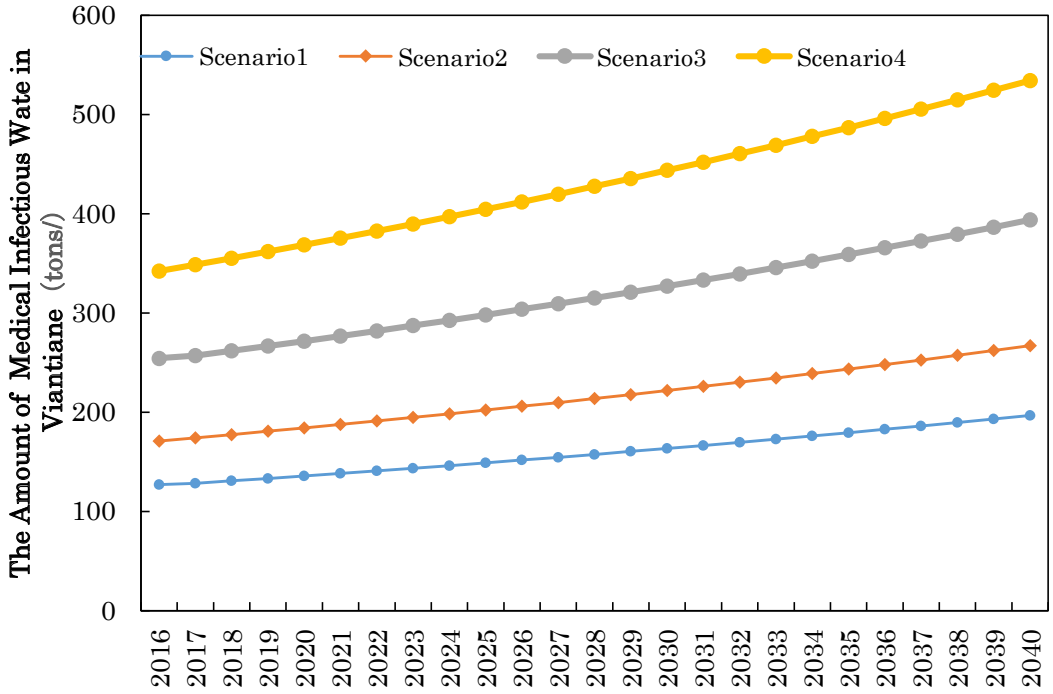
Regarding ②, not only will the waste management laws and regulations in Laos be adhered to, but Japanese standards will also be applied while considering actual local conditions. Regarding cultural acceptability and social impacts, discussions not only with administrative agencies but also with other stakeholders will be held.

CHAPTER 5: CONCRETE PLAN FOR BUSINESS EXPANSION

5-1 Result of Market Analysis

The major medical institutions within Vientiane consign medical waste treatment to VUDAA. As the current medical waste treatment fee is expensive, these institutions can reduce overall costs by installing their own incineration equipment. However, most of the autoclaves and incinerators which have actually been installed in the past have suffered from low build quality and have broken down. These institutions see the high costs of medical waste treatment as an important issue and are hoping that increased market competition from new businesses entering the waste treatment market would reduce their costs.

The below graph shows the expected volume of medical infectious waste in Vientiane derived from simulations using a system dynamics model based on information obtained from interviews with large and medium sized hospitals regarding their bed numbers, in patient and out patient numbers, waste volumes and future management plans as well as statistical information from the national statistics agency.



Simulation Scenarios

	No Segregation of Infectious Waste from General Waste	Segregation of Infectious Waste from General Waste
No Change in Hospital Capacity	Scenario 1	Scenario 3
Increase in Hospital Capacity	Scenario 2	Scenario 4

According to the graph above, under every scenario, the amount of medical infectious waste increases every year as the population grows. Under Scenario 2 and 4, each hospital builds new wards and expands existing ones based on their future management plans. This causes the increment of hospital capacity and therefore increases the amount of medical infectious waste. As of 2020, the amount of medical infectious waste is 136t/year (Scenario 1), 184t/year (Scenario 2), 271t/year (Scenario 3) and 368t/year (Scenario 4). This means 373kg/day (Scenario 1), 505kg/day (Scenario2), 646kg/day (Scenario3) and 1010kg/day (Scenario4).

Regarding hazardous industrial waste, the Ministry of Industry and Commerce provided information that 6,000tons/year (16.5tons/day) is generated in Vientianne and surrounding areas. Taking into account future population growth and economic development, it can be assumed that volumes will be similar to or even exceed medical waste as shown above.

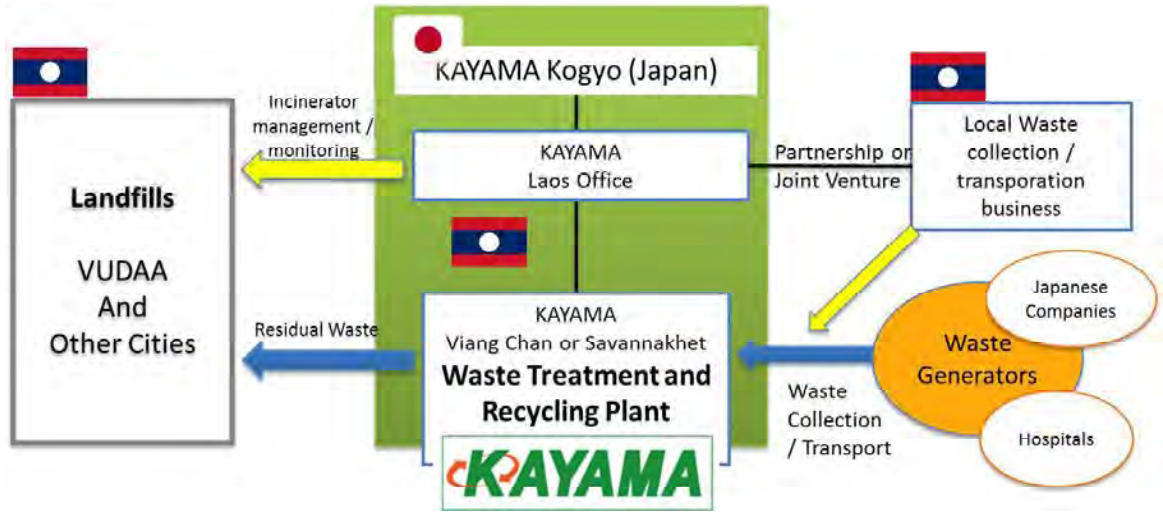
5-2 Business Plan and Development Impact

The main revenue source of waste treatment business is the fee for treating hazardous waste. (In the future if a recycling business of other types of waste is also established, the sales revenue from recycled materials will also become a source). It is important to have firm relationships with local corporations to source waste and charge waste treatment fees. K.P Group, the planned business partner, possesses logistics and construction businesses and also operates manufacturing facilities for multiple Japanese companies. A joint venture or business alliance with a local business partner such as K.P Group will be pursued for business development.

Through interviews with waste generators, it was confirmed that there was demand for the disposal of various recyclable wastes including plastic, wood chips, cardboard and so on in

addition to the need to dispose hazardous waste. Thus, business profitability analysis was performed based on various scenarios taking into account the potential for these recycling opportunities.

Business Model



Assuming that the amount of medical waste per patient remains the same as current levels and the capacity of hospitals increases as planned, it is expected that an incineration capacity of 800kg/day will be required to treat all medical infectious waste generated in Vientiane.

The approximate sales revenue and labor costs are calculated based on interviews with the business partner candidate and multiple waste treatment companies. The treatment fee for medical waste is priced equal to the current fee charged in Vientiane. Also, waste material such as waste oil and sludge will be sourced from local Japanese manufacturers and a treatment fee will be charged based on general market standards. In Japan and other developed countries, medical waste is generally combined with waste oil and sludge as hazardous waste when incinerated.

The proposing company plans to achieve a return on their investment based on a long term strategic view. Upon establishing a business of treating hazardous waste including medical waste, improvement in overall profitability will be pursued through utilizing the various waste treatment and recycling technologies the company possesses to develop multi-faceted businesses in many stages.

As for financing the investment, yen-based loans from Japanese banks are planned to be utilized. Overseas investment and lending is also under consideration. The amount of equity to be injected by the company in the JV is expected to be around 63~126 million yen depending upon the ownership ratio between the company and the business partner. Further funds required at the JV level will be raised through bank loans, but high interest rates in Laos can cause significant financial strains and hence one of the possible measures to improve profitability will be to fully finance the JV through yen loans.

The company will assess the results of the Verification Survey and determine whether to develop their business focused solely in Vientiane or to pursue both the Vientiane and Savannakhet markets.

Feasibility Survey for Improvement of Medical and Other Hazardous Waste Management in Vientiane City, Laos

Company and Counterpart Information

■Proposing Company: Kayama Kogyo Corporation
■Proposing Company Location: Toyokawa City, Aichi Prefecture, Japan
■Counterparty Organization: Vientiane Urban Development Administration Authority (VUDAA)

Development Issues

Improper treatment of medical and other hazardous waste
① Medical waste processed at existing incineration facility exceeds capacity.
② Segregation of medical waste at medical facilities is inadequate

Company's Technology / Product

- Specialized medical waste incinerator to properly treat full volume of medical waste brought in to landfill site
- Incineration management system to improve current incineration process
- Segregation and collection system for medical waste

Proposed ODA Project to follow the Survey and Expected Development Impact

- The proposed ODA project is a "Verification Survey for Improvement of Medical and Other Hazardous Waste Management in Vientiane City". The project will aim to further advance the success of LPPE by targeting remaining issues related to the segregation of medical waste at source, collection and transportation, intermediate treatment and final disposal.
- In particular, verification and dissemination activities will be implemented to address intermediate treatment and collection / transport of medical and other hazardous waste.
- Furthermore, the company's technology and operational know-how for the thorough and proper treatment of waste will be transferred to VUDAA, thus achieving the improvement of medical and other hazardous waste management through the enhanced waste management capability of VUDAA.

Company's Business Development

- The primary business development model will be to leverage the above Verification Survey project to establish a medical and other hazardous waste management business in Vientiane and further expand the geographical coverage to Savannakhet or Pakse.
- An alternative model will be to expand the type of waste to be treated to include general industrial waste and target the waste management needs of Japanese companies in the Vientiane area.